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Mill Creek Area, Jefferson County, Kentucky
Appendix B: Groundwater Program

Gannett Fleming Corddry and Carpenter, Inc.
Harrisburg, PA

Prepared for

Environmental Protection Agency
Atlanta, GA

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This draft EIS addresses proposed wastewater facilities for the Mill Creek ARea of southwest Jefferson County, Kentucky. Numerous wastewater management alternatives ranging from complete reliance on existing on-site systems to a full regional system were evaluated in this EIS. At issue in the Mill Creek Area EIS is the need for EPA to provide Federal funds for sewer service to residential areas currently served by individual on-lot systems and the provision of sewer service to the Louisville-Jefferson County Riverport Industrial Park.

The Draft EIS preferred alternative involves a limited sewer alternative in which the Dixie Highway commercial strip and most, if not all, of the 26 small wastewater treatment plants will be served by a limited sewer. It is proposed that residential areas now served by on-lot systems in the Mill Creek area will remain on these systems.

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Mill Creek
Sewer

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Atlanta, GA 30365

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September 1981

EPA

Environmental Impact Statement

Draft

Mill Creek Area
Jefferson County, Kentucky

Groundwater Program
Appendix B

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U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

GROUNDWATER PROGRAM

APPENDIX B

for

THE MILL CREEK AREA
ENVIRONMENTAL IMPACT STATEMENT
JEFFERSON COUNTY, KENTUCKY

Prepared by
Gannett Fleming Corddry and Carpenter, Inc.
In Association With
Claude Terry & Associates, Inc.

September 1981

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1. SUMMARY AND CONCLUSIONS

The findings of the groundwater investigation are summarized below:

1. Fluoride concentrations suggesting the presence of seepage pit effluent have been detected in many of the wells screened at bedrock.

2. Fecal coliform organisms have been detected in all Phase 2 wells at least one time during the investigation. Consistent fecal coliform presence has been detected in many wells, including several wells screened at bedrock.

3. High nitrate levels have been detected in several Phase 2 wells. Several shallow well samples and one medium well sample have exhibited nitrate levels higher than the federal standard for finished drinking water.

4. Chemical constituent concentrations have varied widely with time at several Phase 2 wells.

The major overall conclusion that is to be drawn from Phase 2 observations is that the Mill Creek portion of the Ohio River alluvial aquifer is influenced at all depths by wastewater from on-site disposal systems. Questions may be raised as to the sources of nitrate and fecal bacteria, and the suggestion that seepage pits represent the predominant source of these pollutants is based upon inference. The source of high fluoride levels observed in the medium and deep wells throughout the study area is most likely LWC water discharged to the aquifer through septic tank seepage pits. The widespread nature of high fluoride observations could not reasonably be assumed to result from water main leaks. Water leaks would be more likely to cause localized fluoride elevations, rather than the high concentrations observed throughout the study area. Water use outside the home, such as lawn watering, could not reasonably be considered as the cause of fluoride peaks observed in deep wells in late October and early November. It is also unlikely that external uses throughout the study area at any time of year are more than a small fraction of total water use in the area.

If the aquifer is influenced at all depths by wastewater from on-site wastewater disposal systems, then it is unsuitable for use as a source of untreated drinking water. Several characteristics of the aquifer suggest that the wastewater influences observed in Mill Creek area groundwater might eventually be reduced if wastewater inputs were removed. The Mill Creek portion of the aquifer receives continuous recharge of essentially clean rainwater. The good hydraulic connection of the saturated zone with the Ohio River allows for continuous, albeit slow, flushing of pollutants introduced into the groundwater. The observations from month to month in Phase 2 investigations support the suggestion that, given time, pollutant washout may occur.

The data collected during Phase 2 do not provide ready answers to all questions regarding the effects of wastewater disposal practices on Mill Creek groundwater. The wide fluctuations of groundwater quality with time, especially in the deeper wells, indicate that the aquifer level at which wastewater may be detected is highly dependent on climatic conditions. Detailed characteristics of aquifer response to precipitation would require modeling of groundwater hydraulics.

2. HYDROGEOLOGIC CONDITIONS

The Mill Creek Study Area is located almost entirely within the boundaries of the Ohio River Alluvial Aquifer. The aquifer was formed during the Pleistocene epoch (the period of glaciation) when the Ohio River cut a deep, wide valley into bedrock to a depth of nearly 40m (130 ft) below the present flood plain. This valley was subsequently filled with glacial outwash sands and gravel and more recent alluvial deposits of silts and clays. (USGS WSP-1819C).

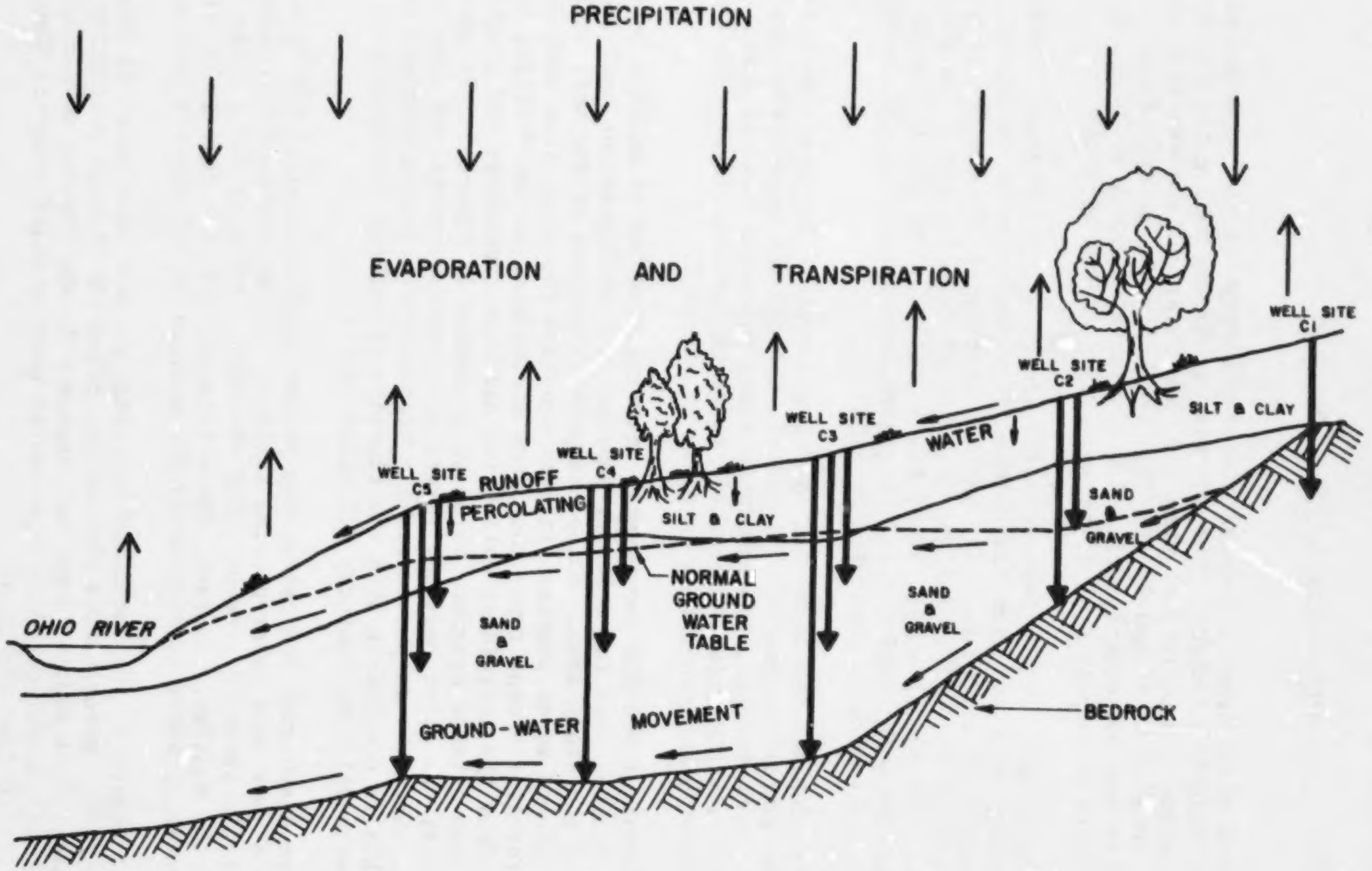
In the geologic time frame, these deposits are relatively recent. Consequently, the deposits have not been transformed into sandstone or shale, but remain as unconsolidated sediments. The bedrock underlying the aquifer is the New Albany shale (USGS WSP 1579, USGS Map G2-1202) of Devonian age. The shale, which is approximately 30m (100 ft) thick, has a gentle dip of about 7.6m/km (40 ft/mi) toward the west (USGS C-276). A generalized diagram of the geologic framework of the study area is presented in Figure 1.

Figure 1 also depicts the localized hydrologic cycle. As water percolates downward from the surface by gravity, it travels through the unsaturated zone to the water table. Upon reaching the saturated zone, the water travels down-gradient in a westerly direction, ultimately reaching the Ohio River. The prevailing direction of groundwater flow is shown in Figure 2.

A major element of the EIS groundwater investigation was to drill a total of 36 wells at 13 sites into the alluvial aquifer in a configuration that would encompass most of the study area. While the primary purpose of the well drilling program was to collect water samples, it also provided the study team with driller's logs of the different sediment types that were encountered at the drilling sites. The information from the individual well sites has been summarized and graphically interconnected into a fence diagram, which is presented in Figure 3. In general, it can be seen that the upper sediment layers are comprised mostly of finer-sized silts and clays, while the deeper layers are predominately coarser-grained sands and gravels. This is consistent with the findings of earlier investigations by the USGS and Commonwealth of Kentucky (HI Atlas HA-111).

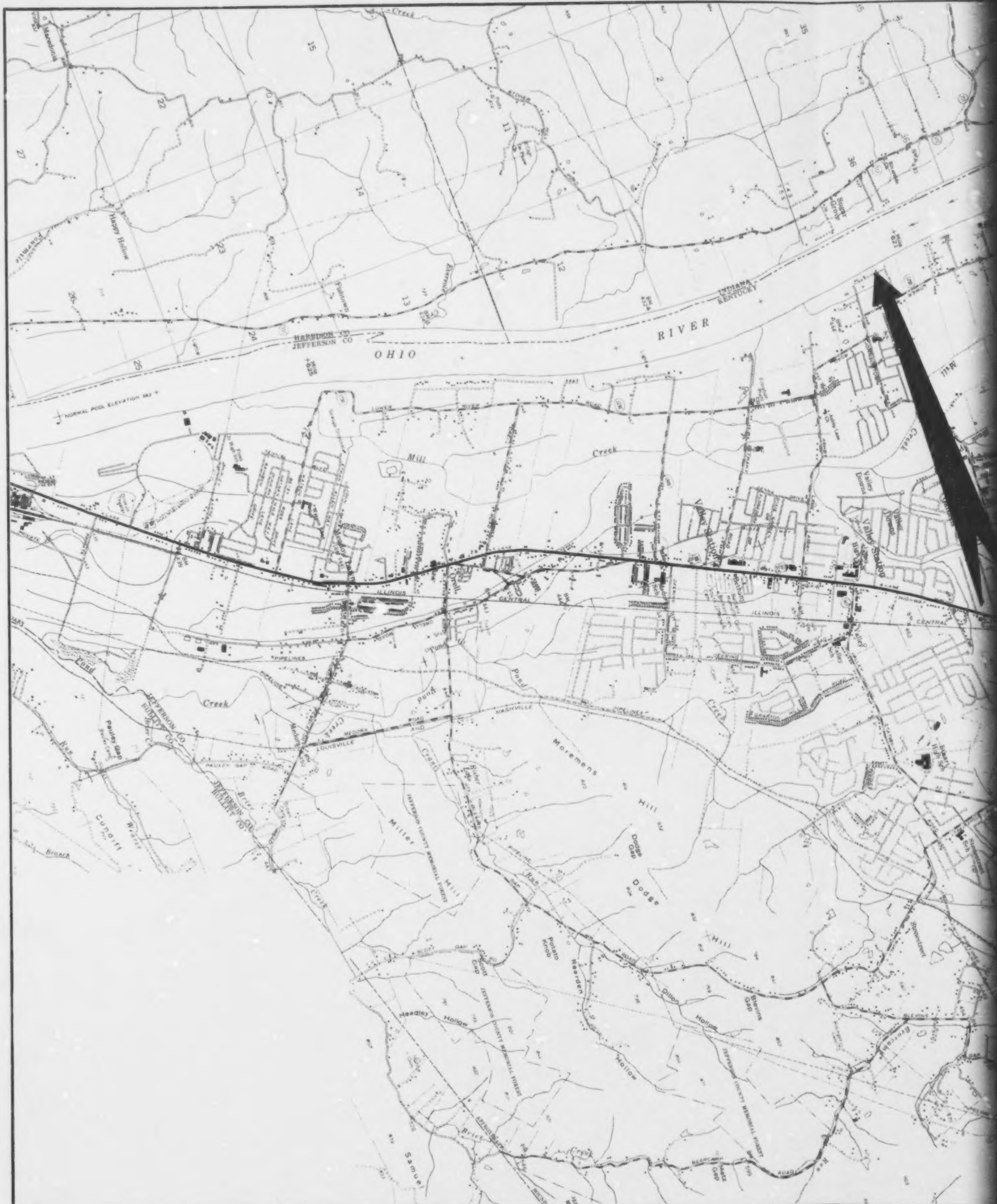
As the above discussion indicates, the proper conditions exist for this formation to be a very good water-bearing aquifer. The porosity of the saturated sands and gravels is about 20 percent (USGS WSP-1579), allowing for a large storage capacity within the aquifer. In fact, the saturated sands and gravels in the study area could potentially store approximately 230 million m^3 (60 billion gal) of water.

As shown in Figure 1, the localized hydrology is such that water is constantly moving in the system. Water enters the aquifer primarily through precipitation and artificial recharge from septic tanks and seepage pits and travels down-gradient to the river. The bedrock serves as an impermeable barrier which prevents flow from moving eastward, away from the river.


PRECIPITATION
EVAPORATION
AND
TRANSPIRATION
WELL SITE C1
WELL SITE C2
WELL SITE C3
WELL SITE C4
WELL SITE C5
SILT & CLAY
WATER
SAND & GRAVEL
RUNOFF
PERCOLATING
SILT & CLAY
NORMAL GROUND WATER TABLE
SAND & GRAVEL
OHIO RIVER
SAND & GRAVEL
GROUND-WATER
MOVEMENT
BEDROCK

LOCALIZED HYDROLOGIC CYCLE IN STUDY AREA

FIGURE


OHIO
RIVER
INDIANA
KENTUCKY
HARRISON CO
JEFFERSON CO
NORMAL POOL ELEVATION 383
Happy Hollow
Sugar Grove
Mill
Creek
Mill Creek
ILLINOIS
CENTRAL
PIPELINES
Pond
Creek
Pond Creek
NASHVILLE
LOUISVILLE
MEDORA
JEFFERSON CO
BULLITT CO
Pauley Gap
Cundiff
Branch
Brier
Moremens
Hill
Miller
Hill
Dodge Gap
Dodge
Hill
Potato Knob
Scott Gap
Rearden
Dillon
Hollow
Stevens Gap
Headley Hollow
Samuel
Valley Station
Valley Downs
JEFFERSON COUNTY MEMORIAL FOREST
22
27
23
24
25
26
15
14
13
12
11
2
1
35
36

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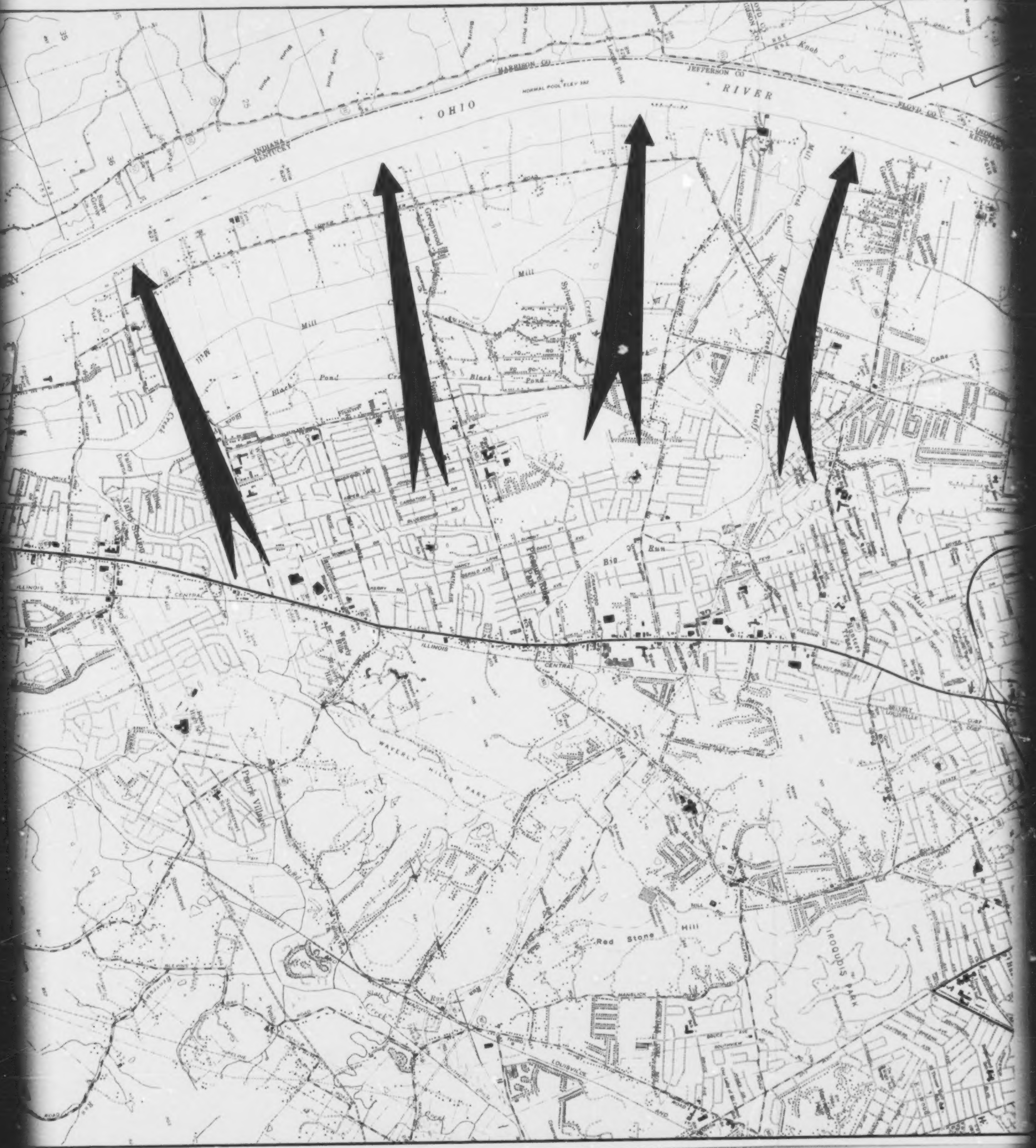
OHIO
RIVER
INDIANA
KENTUCKY
HARRISON CO
JEFFERSON CO
FLOYD CO
NORMAL POOL ELEV 382
Mill
Black
Pond
Creek
Sylvania
Greenwood
Cutoff
Knob
Cane
Valley Station
ILLINOIS
CENTRAL
Big
Run
Pleasure Ridge Park
WAVERLY HILLS PARK
Prairie Village
Red Stone Hill
IROQUOIS PARK

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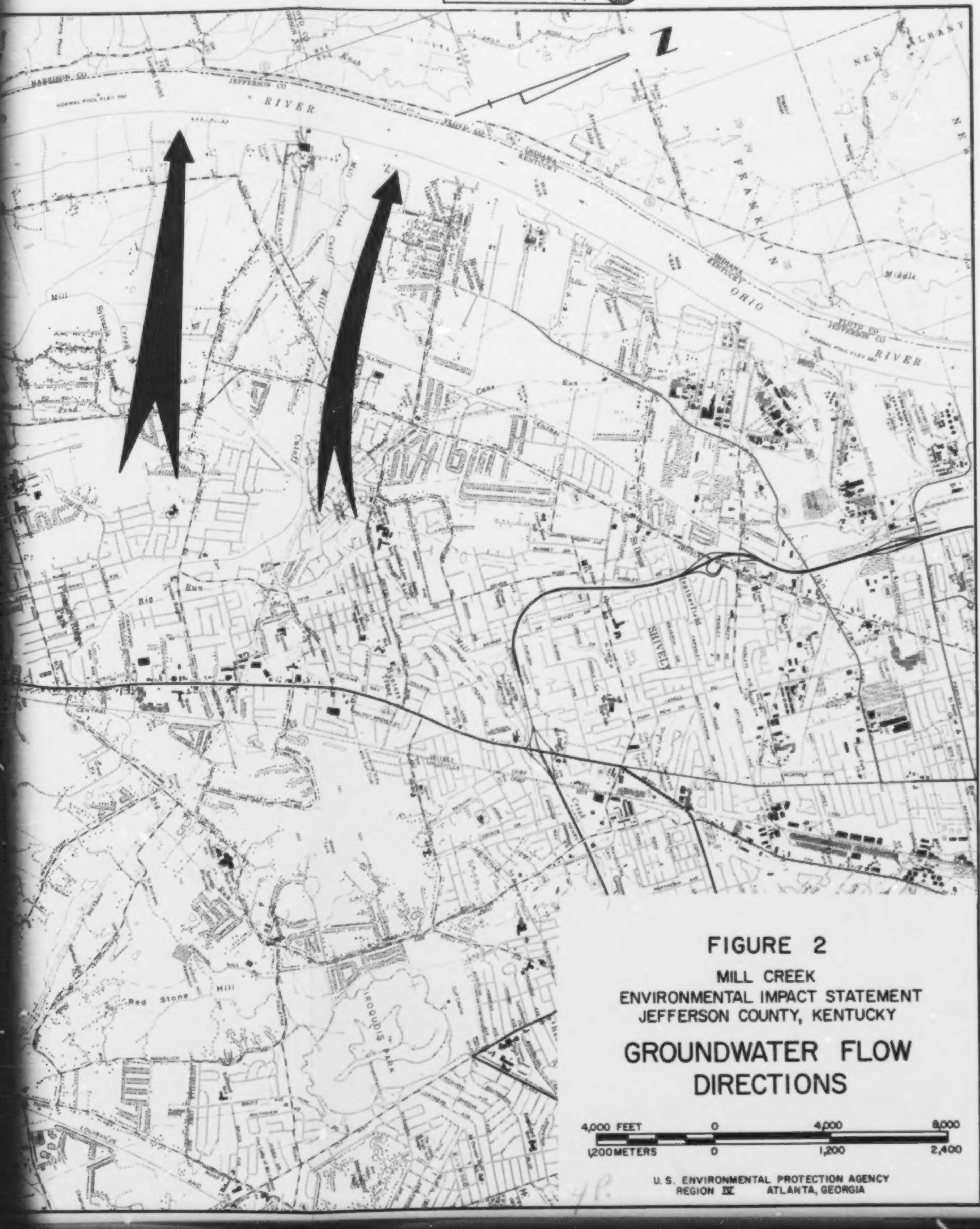
N
RIVER
OHIO
RIVER
HARRISON CO
JEFFERSON CO
FLOYD CO
INDIANA
KENTUCKY
FRANKLIN
NEW ALBANY
Middle
Mill Creek
Big Run
Cane Run
SHIVELY
Red Stone Hill
IROQUOIS PARK

FIGURE 2

MILL CREEK
ENVIRONMENTAL IMPACT STATEMENT
JEFFERSON COUNTY, KENTUCKY

GROUNDWATER FLOW DIRECTIONS

4,000 FEET 0 4,000 8,000
1,200 METERS 0 1,200 2,400

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REGION IV ATLANTA, GEORGIA

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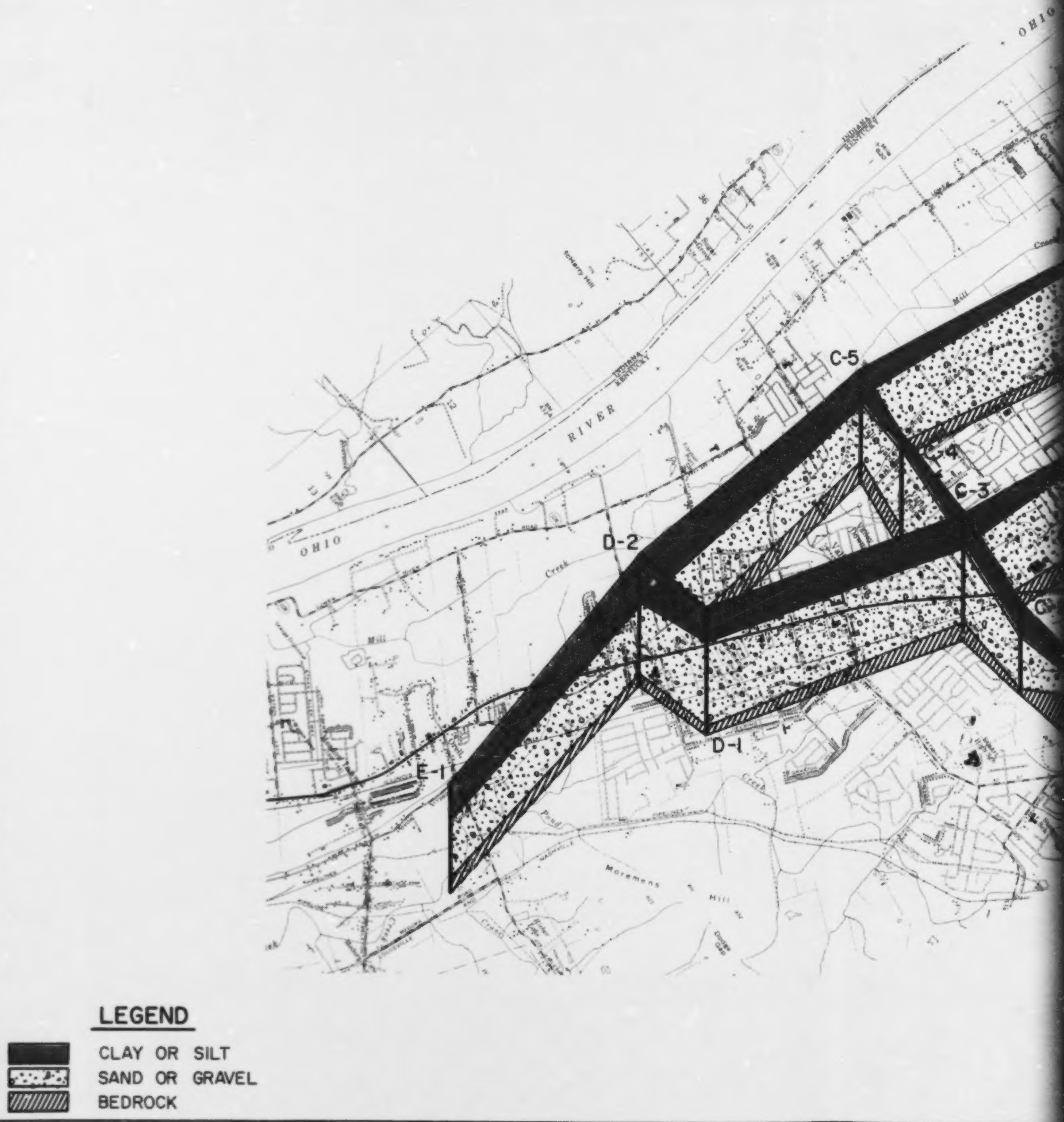
5.


OHIO
INDIANA
KENTUCKY
RIVER
OHIO
C-5
C-4
C-3
D-2
D-1
E-1
Mill
Creek
Moremens
Hill
LEGEND
■ CLAY OR SILT
▨ SAND OR GRAVEL
▨ BEDROCK

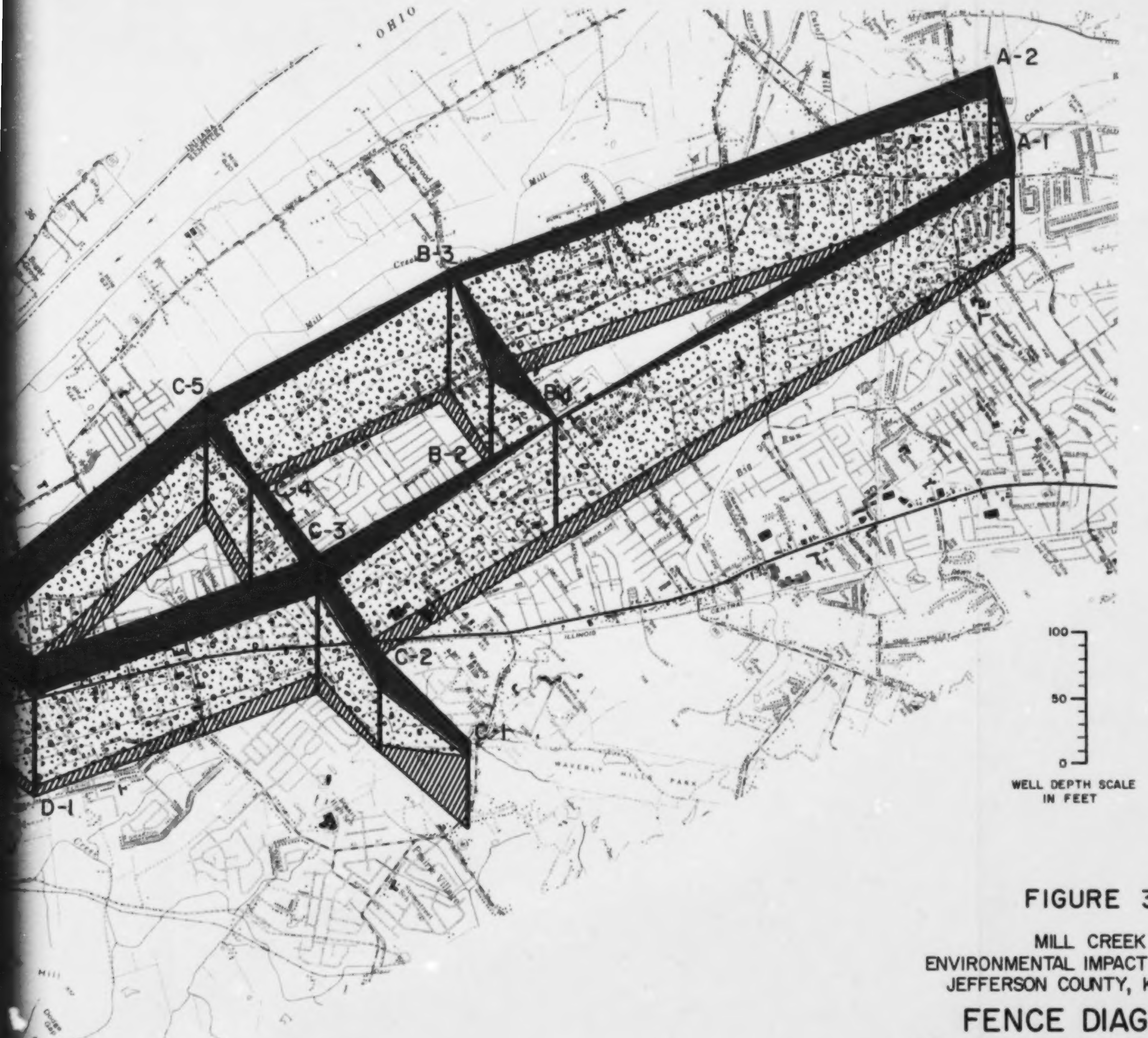

OHIO
A-2
A-1
B-3
B-1
B-2
C-5
C-4
C-3
C-2
C-1
D-1
ILLINOIS
WAVERLY HILLS PARK
Mill
Creek
100
50
0
WELL DEPTH SCALE
IN FEET

FIGURE 3

MILL CREEK
ENVIRONMENTAL IMPACT STATE
JEFFERSON COUNTY, KENTUC

FENCE DIAGRAM OF ALLUVIAL DEPO IN THE STUDY AR

4,000 FEET 0 4,000
1,200 METERS 0 1,200

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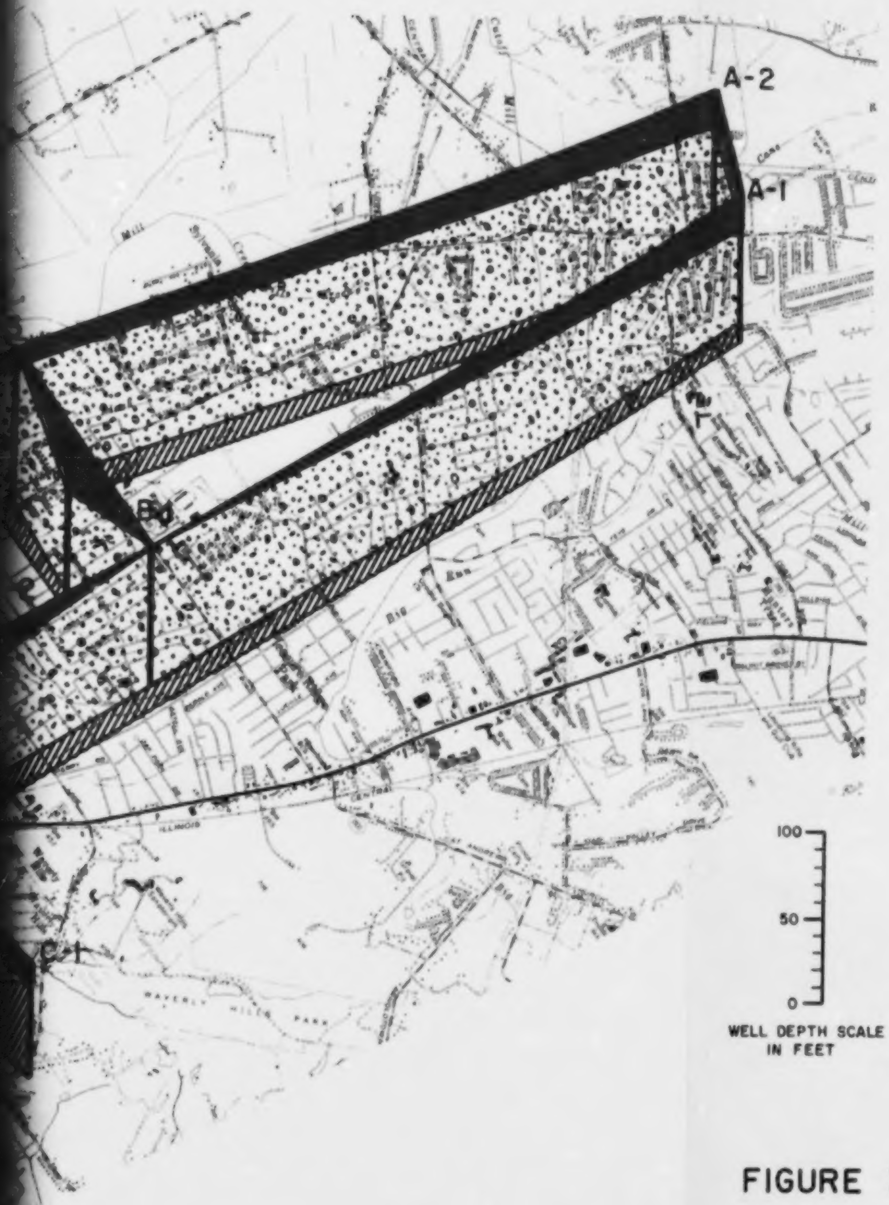
A-2
A-1
100
50
0
WELL DEPTH SCALE
IN FEET

FIGURE 3

MILL CREEK
ENVIRONMENTAL IMPACT STATEMENT
JEFFERSON COUNTY, KENTUCKY

FENCE DIAGRAM OF ALLUVIAL DEPOSITS IN THE STUDY AREA

4,000 FEET 0 4,000 8,000
1,200 METERS 0 1,200 2,400

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REGION IV ATLANTA, GEORGIA

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The annual average precipitation in the area is approximately 109cm (43 in) per year. (NOAA, 1979). It has been estimated that approximately 15cm (6 in) per year of precipitation enters the aquifer from the surface (USGS C-276). An evaluation of the variations in gradient indicates that the groundwater flow velocity may vary from less than 0.6m (2 ft) per day to perhaps as much as 3m (10 ft) per day in some portions of the study area. All of the water flows to the river/aquifer boundary. In the study area, there is a good hydraulic connection between the river and the alluvium (USGS WSP 1819C). This means that there is almost unimpeded flow from the aquifer into the river, under the conditions of normal river stage.

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3. PHASE 1 GROUNDWATER INVESTIGATION

Groundwater quality data for the Mill Creek area was compiled and evaluated in order to determine the scope of the groundwater investigation required to fulfill the needs of the EIS. Findings regarding the extent of existing information were reported in the Interim Groundwater Report in February, 1979. Historical groundwater quality data were found to be too sparsely distributed in time and space to allow meaningful conclusions to be drawn regarding the effects of wastewater disposal practices on subsurface water. In order to provide a comprehensive, reliable basis for conclusions, a two-phase groundwater investigation program was developed for the EIS.

The first phase investigation was to involve the one-time sampling of about 100 existing private wells in the study area. This canvass sampling was planned with several objectives:

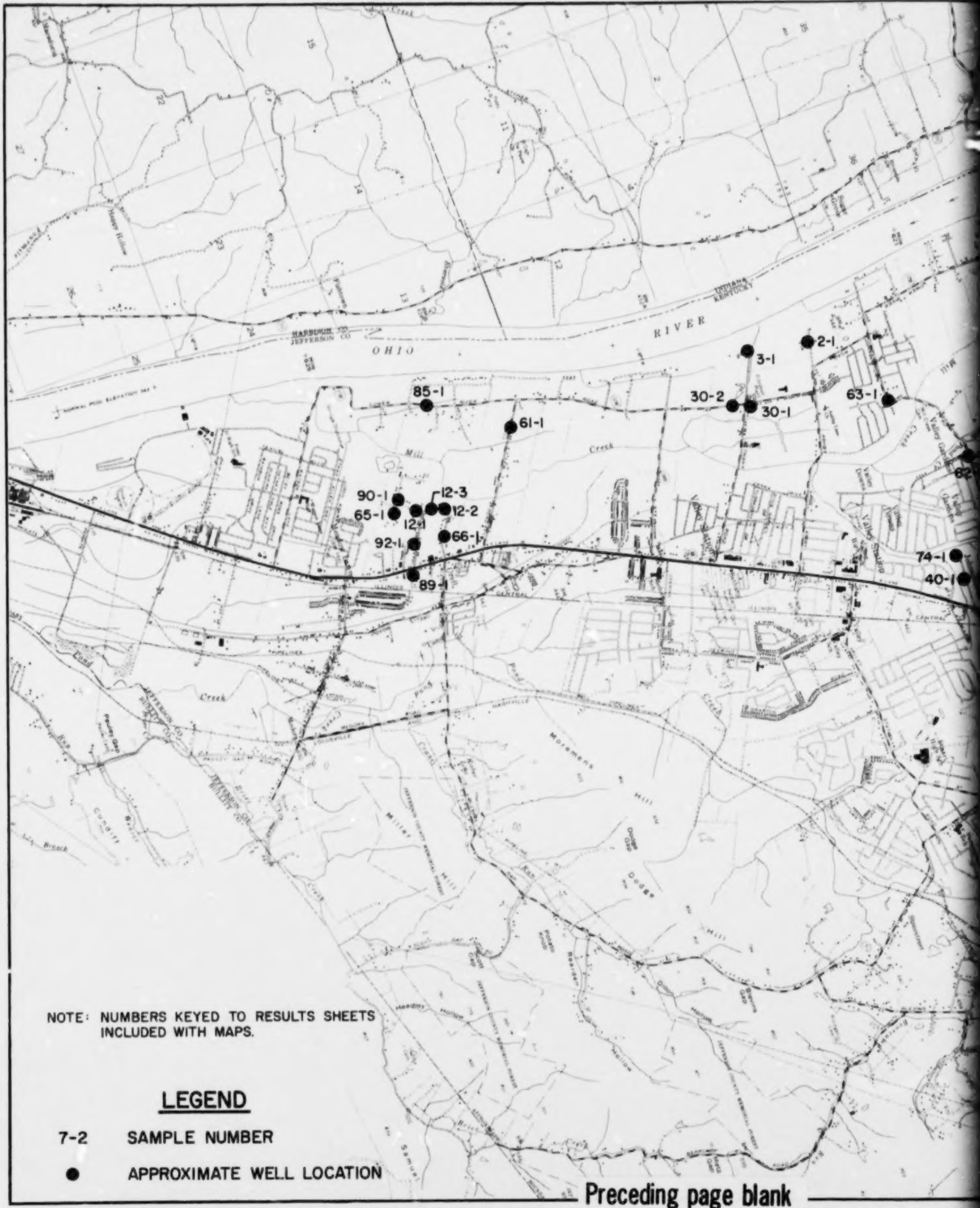
1. An overall picture of general groundwater quality could be determined fairly quickly.

2. Particular problem areas might be identified.

3. Appropriate parameters for analysis in future sampling could be identified.

Private wells for the canvass sampling program were identified by comparison of Louisville Water Company billing records to property addresses listed in the 1978 Louisville Suburban Directory. Three hundred possible residences with wells were identified, and 110 households contacted consented to the sampling. Sample locations are shown in Figure 4. Sampling and analysis were carried out in December, 1978. The Phase 1 work effort was planned as a rapid, relatively inexpensive sampling program to meet the objectives described above. Certain probable limitations in sampling quality control were recognized at the outset of Phase 1, and the results of the work were to be evaluated in light of those constraints. Sampling personnel did not solicit information from home owners regarding well depth, well age, casing and screen material, and well condition. At the time of installation of the private wells in the study area, a mechanism for public filing of drilling logs and well completion reports was not in effect. Telephone conversations with many home owners indicated that, because of sales of residences during the years following well installation, few home owners would be able to provide reliable information regarding well depth, materials, and condition.

In spite of the limitations noted above, the sampling provided information on approximate groundwater quality across the study area. Although specific knowledge of well depths was not acquired, it is probably a valid assumption that the 102 wells that were sampled are screened at a variety of depths. Thus, Phase 1 results may be accepted as "order of magnitude" indications of groundwater quality.


OHIO
RIVER
INDIANA
KENTUCKY
HARRISON CO
JEFFERSON CO
Mill Creek
Pond Creek
Moremens Hill
Dodge Hill
Miller Hill
85-1
61-1
3-1
2-1
30-2
30-1
63-1
82
90-1
12-3
65-1
12-2
12-1
92-1
66-1
89-1
74-1
40-1
ILLINOIS CENTRAL

NOTE: NUMBERS KEYED TO RESULTS SHEETS
INCLUDED WITH MAPS.

LEGEND

7-2	SAMPLE NUMBER
●	APPROXIMATE WELL LOCATION

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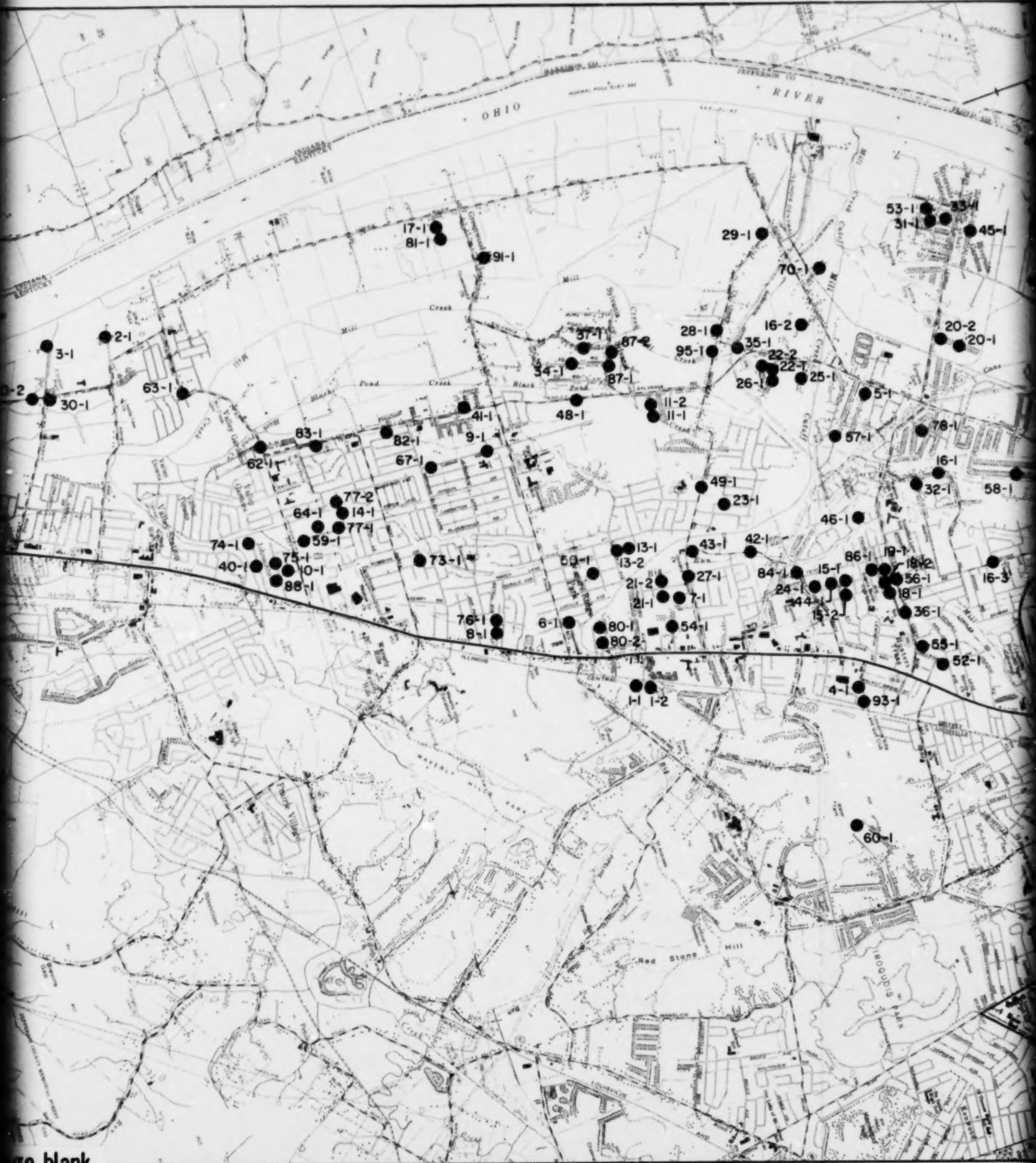
OHIO
RIVER
INDIANA
KENTUCKY
Knob
Mill
Creek
Black
Pond
Creek
Red Stone Hill
IROQUOIS PARK
17-1
81-1
91-1
29-1
53-1
33-1
31-1
45-1
70-1
3-1
2-1
28-1
16-2
37-1
87-2
95-1
35-1
20-2
20-1
34-1
87-1
22-2
22-1
26-1
25-1
0-2
30-1
63-1
48-1
11-2
11-1
5-1
41-1
83-1
82-1
9-1
57-1
78-1
62-1
67-1
16-1
32-1
58-1
49-1
23-1
77-2
14-1
64-1
77-1
46-1
59-1
74-1
13-1
13-2
43-1
42-1
40-1
75-1
10-1
73-1
50-1
86-1
19-1
19-2
84-1
15-1
56-1
16-3
88-1
21-2
27-1
24-1
18-1
21-1
7-1
44-1
15-2
36-1
76-1
8-1
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80-1
54-1
80-2
55-1
52-1
4-1
93-1
1-1
1-2
60-1

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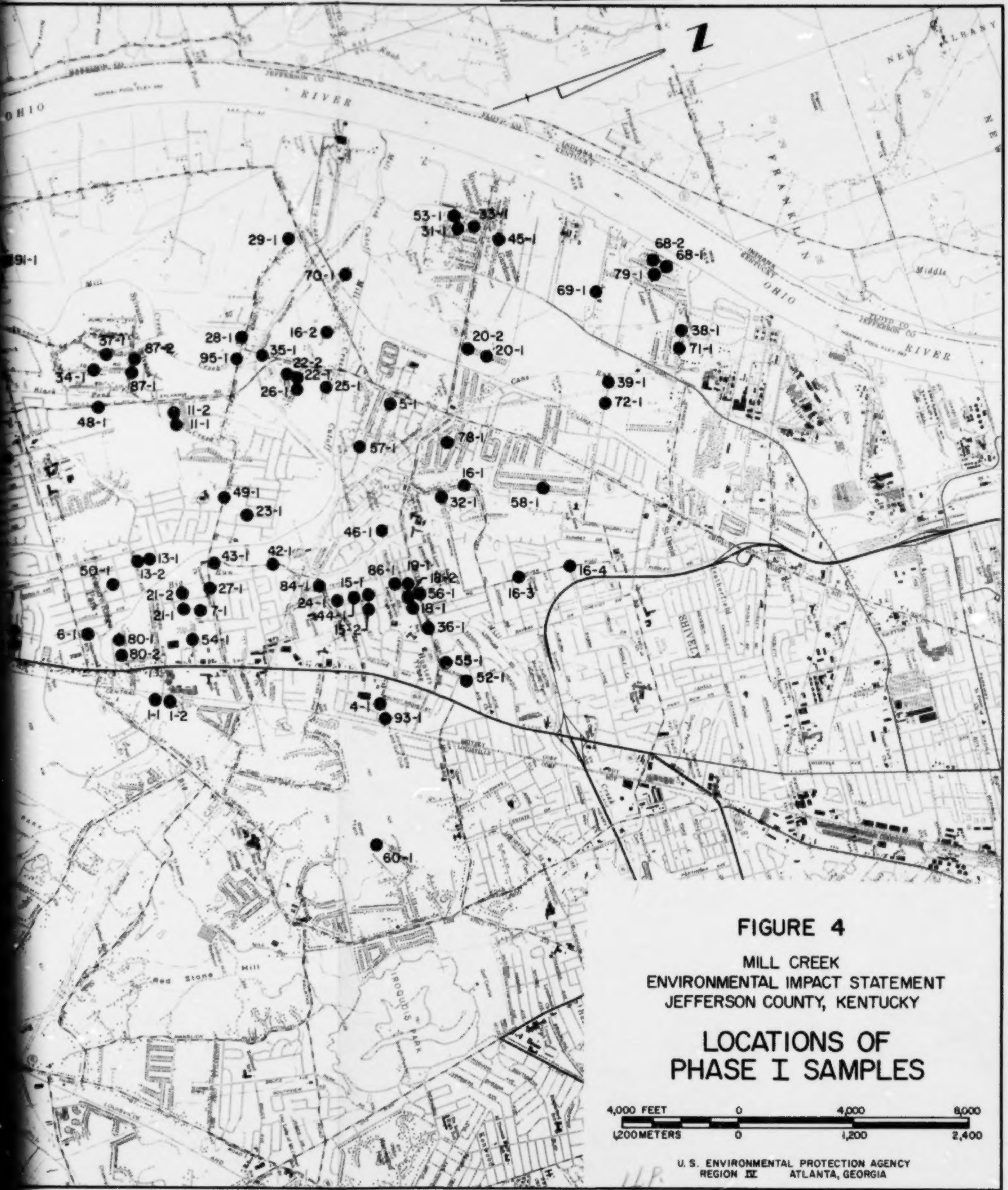
OHIO
RIVER
NEW ALBANY
FRANKLIN
INDIANA
KENTUCKY
OHIO
RIVER
Middle
FLOYD CO
JEFFERSON CO
SHIVELY
IROQUOIS PARK
Red Stone Hill
Mill Creek
91-1
29-1
53-1
33-1
31-1
45-1
70-1
68-2
68-1
79-1
69-1
16-2
28-1
95-1
35-1
37-1
87-2
34-1
87-1
22-2
22-1
26-1
25-1
20-2
20-1
38-1
71-1
39-1
72-1
5-1
11-2
11-1
48-1
57-1
78-1
16-1
32-1
58-1
49-1
23-1
46-1
13-1
13-2
43-1
42-1
50-1
27-1
21-2
21-1
7-1
86-1
19-1
18-2
56-1
18-1
84-1
15-1
24-1
44-1
15-2
16-4
16-3
36-1
6-1
80-1
80-2
54-1
55-1
52-1
1-1
1-2
4-1
93-1
60-1

FIGURE 4

MILL CREEK
ENVIRONMENTAL IMPACT STATEMENT
JEFFERSON COUNTY, KENTUCKY

LOCATIONS OF PHASE I SAMPLES

4,000 FEET 0 4,000 8,000
1,200 METERS 0 1,200 2,400

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REGION IV ATLANTA, GEORGIA

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Phase 1 samples were analyzed for the following constituents:

1. Nitrate nitrogen
2. Ammonia nitrogen
3. Total phosphorus
4. Chloride
5. Conductivity
6. Total iron
7. Fecal coliform
8. Fecal streptococci

The results of the canvass sampling program are presented in Table 1. Brief summaries of findings are presented here to provide a basis for decisions regarding the second phase of the groundwater program.

Nitrate concentrations were found to range from less than 0.01 mg/l as N to 9.4 mg/l as N. While no groundwater sample exhibited nitrate at a concentration exceeding the federal standard for finished drinking water (10 mg/l as N), several of the samples contained nitrate at levels which suggested the presence of wastewater in certain areas.

Ammonia, fecal bacteria, and iron were found in several samples, but appeared to be unrelated to any particular locality or cultural feature. These pollutants were thought to be related to specific problems with individual wells. Total phosphorus, conductivity, and chloride results were inconclusive.

At the time of Phase 1 sampling, the general quality of Mill Creek groundwater appeared to satisfy federal standards for finished drinking water. Occurrences of standard violations probably reflected deficiencies of specific wells rather than a more widespread problem. However, the relatively high nitrate concentrations observed in several of the samples indicated the possibility of widespread wastewater contamination of the groundwater. On the basis of canvass sampling results, it was decided to proceed with a comprehensive, controlled sampling program to characterize groundwater quality and identify pollutant sources.

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TABLE 1. CANVASS SAMPLING RESULTS

LOUISVILLE MILL CREEK STUDY AREA

Samp. No.	Date Col.	NO_3-N mg/l as N	NH_3-N mg/l as N	Total P mg/l as P	Chloride mg/l as Cl	Fecal Coli. /100 ml	Fecal Strep. /100 ml	Conductivity µmhos/cm	Total Fe mg/l
1-1	12/15	0.89	<0.04[a]	0.05	8	0	0	627	0.06
1-2	12/15	0.39	<0.04	0.07	8	0	0	624	<0.05
2-1	12/18	0.01	<0.04	0.15	26	0	0	766	0.36
3-1	12/18	1.27	<0.04	0.16	26	0	1	713	0.09
4-1	12/13	8.45	<0.04	0.06	29	0	0	843	<0.05
5-1	12/11	1.99	<0.04	0.21	33	0	0	895	0.06
6-1	12/15	3.30	<0.04	0.03	64	0	0	991	<0.05
7-1	12/15	4.15	<0.04	0.22	59	0	0	977	<0.05
8-1	12/15	0.55	<0.04	0.13	62	0	0	1050	<0.05
8-2	12/15	3.75	<0.04	0.15	29	0	0	903	<0.05
9-1	12/19	5.07	<0.04	0.23	31	0	0	910	<0.05
10-1	12/15	9.31	<0.04	0.12	62	0	0	1060	<0.05
11-1	12/15	5.55	<0.04	0.05	29	0	0	719	<0.05
11-2	12/15	3.90	<0.04	0.07	20	0	0	632	<0.05
12-1	12/18	0.05	<0.04	0.18	34	0	0	755	0.09
12-2	12/18	0.59	<0.04	0.17	51	0	0	798	0.06
12-3	12/18	0.14	<0.04	0.11	45	0	0	736	0.06
13-1	12/15	0.09	<0.04	0.14	30	0	0	775	<0.05
13-2	12/15	0.01	<0.04	0.07	27	0	0	727	<0.05
14-1	12/15	1.15	<0.04	0.07	42	0	0	938	<0.05
15-1	12/13	0.79	<0.04	0.34	37	0	0	938	<0.05
15-2	12/13	3.07	0.27	0.18	40	0	42	975	<0.05
16-1	12/11	0.15	<0.04	0.08	25	0	0	873	3.48
16-2	12/11	3.70	0.15	0.15	26	0	0	755	<0.05
16-3	12/13	0.65	<0.04	0.06	29	0	0	810	<0.05
16-4	12/13	9.40	<0.04	0.14	29	0	0	814	<0.05
18-1	12/13	0.15	<0.04	0.11	31	0	0	832	1.97
18-2	12/13	5.95	3.25	0.07	25	0	0	871	<0.05
19-1s[b]	12/13	5.20	0.31	0.16	35	0	130	955	<0.05
19-1w[b]	12/13	5.20	0.31	0.07	36	0	0	960	<0.05
20-1	12/11	7.95	<0.04	0.18	32	0	0	920	<0.05

TABLE 1. (CONT.)

Samp. No.	Date Col.	NO_3-N mg/l as N	NH_3-N mg/l as N	Total P mg/l as P	Chloride mg/l as Cl	Fecal Coli. /100 ml	Fecal Strep. /100 ml	Conductivity µmhos/cm	Total Fe mg/l
20-2	12/11	2.92	<0.04	0.18	33	0	0	908	<0.05
21-1	12/18	0.12	<0.04	0.12	23	0	0	649	<0.05
21-2	12/15	1.37	0.11	0.17	37	0	0	665	<0.05
22-1	12/11	2.73	<0.04	0.13	30	0	0	888	<0.05
22-2	12/11	4.60	<0.04	0.27	30	0	0	850	<0.05
23-1	12/15	1.36	0.85	0.07	62	0	0	895	<0.05
24-1	12/13	0.28	<0.04	0.13	42	0	0	872	<0.05
25-1	12/11	5.50	<0.04	0.16	25	0	0	750	<0.05
26-1	12/11	4.35	<0.04	0.07	35	0	0	855	<0.05
27-1	12/15	0.63	0.57	0.07	48	0	0	869	<0.05
28-1	12/11	0.30	<0.04	0.09	23	0	0	749	0.10
29-1	12/11	1.80	<0.04	0.32	34	0	0	737	0.08
30-1	12/18	0.02	<0.04	0.06	28	0	0	849	2.49
30-2	12/18	1.40	<0.04	0.08	31	0	0	876	<0.05
31-1	12/11	2.33	<0.04	0.65	33	0	0	783	0.06
32-1	12/13	0.55	<0.04	0.08	27	0	48	874	<0.05
33-1	12/11	4.20	<0.04	0.18	30	0	0	790	0.05
35-1	12/11	0.18	<0.04	0.17	20	0	0	693	0.06
36-1	12/13	0.24	<0.04	0.09	32	0	0	932	0.15
37-1	12/19	0.30	<0.04	0.15	37	0	0	838	<0.05
38-1	12/11	0.14	<0.04	0.02	20	0	0	732	9.59
39-1	12/11	2.35	5.75	0.12	35	0	0	879	<0.05
40-1	12/15	4.15	<0.04	0.07	71	0	1	940	0.06
41-1	12/18	5.91	<0.04	0.08	33	0	0	914	<0.05
42-1	12/15	2.68	<0.04	0.11	41	0	16	810	<0.05
43-1	12/15	2.15	<0.04	0.07	59	0	1	947	<0.05
44-1	12/13	2.32	0.32	0.08	36	0	0	930	<0.05
45-1	12/11	4.85	<0.04	0.40	22	0	0	738	0.06
46-1	12/13	1.05	<0.04	0.29	26	0	0	802	<0.05
48-1	12/18	6.40	<0.04	0.08	35	47	0	962	<0.05
49-1	12/11	3.15	<0.04	0.23	30	0	0	839	<0.05

TABLE 1. (CONT.)

Samp. No.	Date Col.	NO_3-N mg/l as N	NH_3-N mg/l as N	Total P mg/l as P	Chloride mg/l as Cl	Fecal Coli. /100 ml	Fecal Strep. /100 ml	Conductivity µmhos/cm	Total Fe mg/l
50-1	12/15	2.28	<0.04	0.06	51	0	0	938	<0.05
52-1	12/13	0.15	<0.04	0.04	41	0	0	941	8.71
53-1	12/11	2.91	<0.04	0.11	32	0	0	721	<0.05
54-1	12/15	0.02	<0.04	0.05	75	0	0	941	0.06
55-1	12/13	5.35	<0.04	0.10	38	0	0	930	<0.05
56-1	12/13	1.10	<0.04	0.16	26	0	0	837	<0.05
57-1	12/11	0.14	<0.04	0.17	23	0	0	770	<0.05
58-1	12/15	<0.01	<0.04	0.07	34	0	1	862	7.81
60-1	12/13	0.34	0.47	0.02	168	0	0	1330	20.6
61-1	12/18	0.53	<0.04	0.04	10	0	0	244	<0.05
62-1	12/18	4.45	<0.04	0.08	22	0	0	807	<0.05
63-1	12/18	1.69	<0.04	0.11	19	0	25	820	<0.05
64-1	12/15	2.00	<0.04	0.04	43	0	4	892	<0.05
66-1	12/18	1.73	<0.04	0.10	30	0	0	721	<0.05
67-1	12/19	2.23	<0.04	0.37	37	0	0	957	<0.05
68-1	12/19	2.02	<0.04	0.10	20	0	0	726	<0.05
68-2	12/19	2.05	<0.04	0.14	27	0	0	684	<0.05
69-1	12/19	0.60	<0.04	0.10	17	0	1	750	<0.05
70-1	12/19	5.63	<0.04	0.21	26	0	0	750	<0.05
71-1	12/19	0.04	<0.04	0.38	42	0	21	885	5.71
72-1	12/19	1.53	<0.04	0.20	35	0	55	905	0.06
74-1	12/15	3.08	4.89	0.03	83	0	0	983	<0.05
75-1	12/15	2.76	0.15	0.18	40	0	0	878	<0.05
76-1	12/15	1.26	0.86	0.03	71	0	0	975	<0.05
77-1	12/15	6.20	<0.04	0.05	39	0	0	927	<0.05
77-2	12/15	3.00	<0.04	0.06	32	0	0	860	<0.05
78-1	12/19	0.75	<0.04	0.11	11	0	0	283	<0.05
79-1	12/19	0.01	<0.04	0.21	33	0	20	785	<0.05
80-1	12/15	6.26	0.25	0.05	67	12	0	1170	<0.05
82-1	12/21	0.50	<0.04	0.26	24	0	0	678	<0.05
83-1	12/18	0.70	<0.04	0.07	36	0	0	979	0.06

TABLE 1. (CONT.)

Samp. No.	Date Col.	NO_3-N mg/l as N	NH_3-N mg/l as N	Total P mg/l as P	Chloride mg/l as Cl	Fecal Coli. /100 ml	Fecal Strep. /100 ml	Conductivity μmhos/cm	Total Fe mg/l
84-1	12/15	1.36	<0.04	0.13	45	0	0	756	<0.05
85-1	12/18	0.61	<0.04	0.04	22	0	0	750	<0.05
86-1	12/21	0.06	<0.04	0.22	31	0	0	925	3.33
87-2	12/18	1.62	<0.04	0.08	14	0	0	630	<0.05
88-1	12/19	3.15	<0.04	0.22	44	0	21	924	<0.05
90-1	12/21	0.50	<0.04	0.23	50	0	0	785	<0.05
92-1	12/21	1.05	<0.04	0.07	12	0	0	311	<0.05
93-1	12/21	2.54	<0.04	0.25	14	0	8	800	<0.05
95-1	12/11	2.28	<0.04	0.15	26	0	0	787	<0.05

Notes:

a) Symbol < signifies "less than."

b) 19-1s is a sample after water softening.
19-1n is the same water without softening.

c) 61-1 is actually Louisville Water Company water.

4. PHASE 2 GROUNDWATER INVESTIGATION

4.1 PHASE 2 OBJECTIVES

Limitations of the Phase 1 groundwater program disallowed the development of specific conclusions regarding the quality of groundwater in the Mill Creek study area. Phase 1 results did, however, recommend additional, formalized sampling and analysis of area groundwater in order to verify or refute the general observations developed in the canvass sampling. The Phase 2 groundwater program was planned to meet several objectives:

1. To provide statistically reliable data, from several months of sampling, which would characterize the quality of groundwater throughout the Mill Creek study area.

2. To provide data regarding the short-term (month-to-month) changes in groundwater depth and quality parameters.

3. To provide data from which the effects on groundwater of various cultural activities might be deduced.

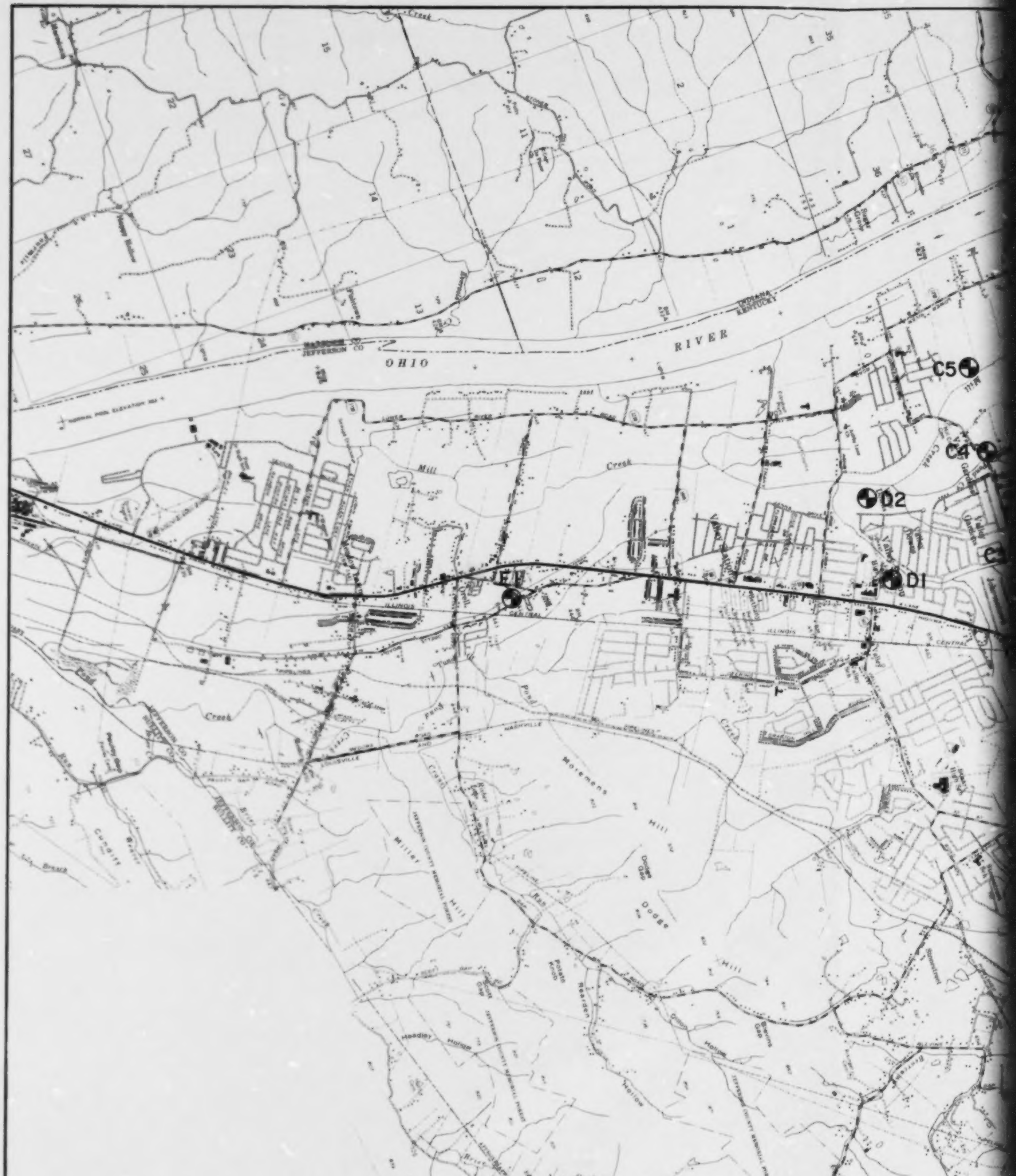
4.2 SAMPLING WELL NETWORK

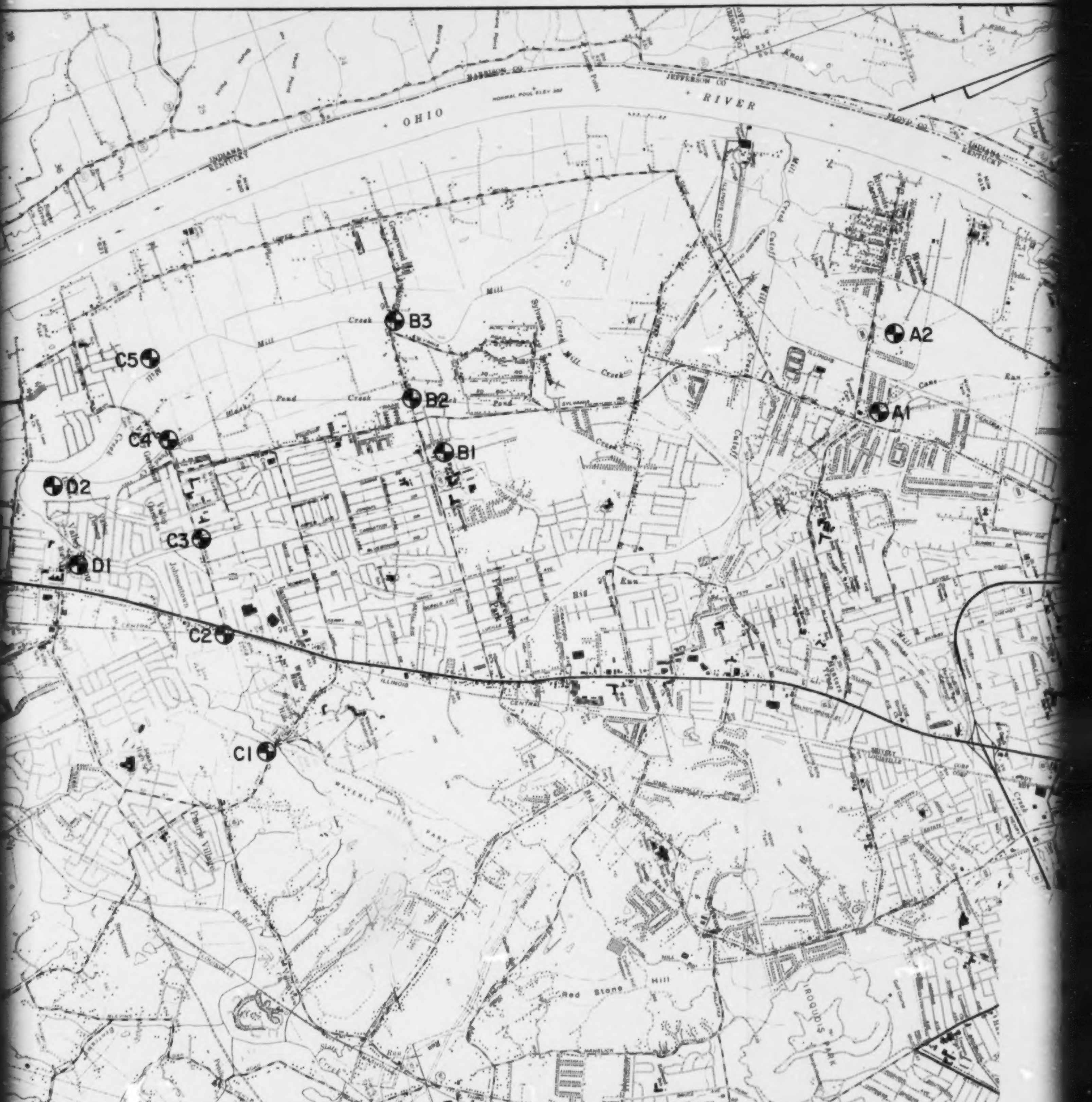
4.2.1 General Approach

The sampling well network was developed to provide access to groundwater at various depths at many different locations in the study area. Further, sets of wells were arranged to intercept groundwater generally along a flow path from the east toward the Ohio River, to provide insight into the progressive effects of land surface activities on subsurface water as it flows toward the river. Well sites were generally provided with three separate wells, one established just above bedrock, (deep well--"d"), one established several feet below the water table observed at the time of drilling (shallow well--"s"), and a third established midway between the other two (middle well--"m").

4.2.2 Well Site Locations

Locations of well sites are presented on Figure 5. Sites A-1 and A-2 were established to intercept groundwater up-gradient and down-gradient from the residential areas known as the Idle Hour and the Cane Run Road subdivisions. These sampling points were established in part to determine what effects, if any, industrial activity in the northern portion of the study area has on groundwater quality. Site A-1 consists of three separate wells (A-1-s, A-1-m, A-1-d), as does site A-2 (A-2-s, A-2-m, A-2-d).


OHIO
RIVER
INDIANA
KENTUCKY
HARRISON CO
JEFFERSON CO
NORMAL POOL ELEVATION 383
Mill
Creek
Pond
Creek
ILLINOIS
CENTRAL
NASHVILLE
LOUISVILLE
Moremens
Hill
Dodge
Hill
Miller
Hoodley
Hollow
Reardon
Samuel
C5
C4
D2
D1
E1
C3


OHIO
RIVER
INDIANA
KENTUCKY
JEFFERSON CO
FLOYD CO
B3
A2
C5
Mill
Creek
Pond
B2
A1
C4
B1
D2
C3
D1
C2
Big Run
ILLINOIS CENTRAL
C1
Red Stone Hill
IROQUOIS PARK
4,000 f
1,200

Reproduced from
best available copy.

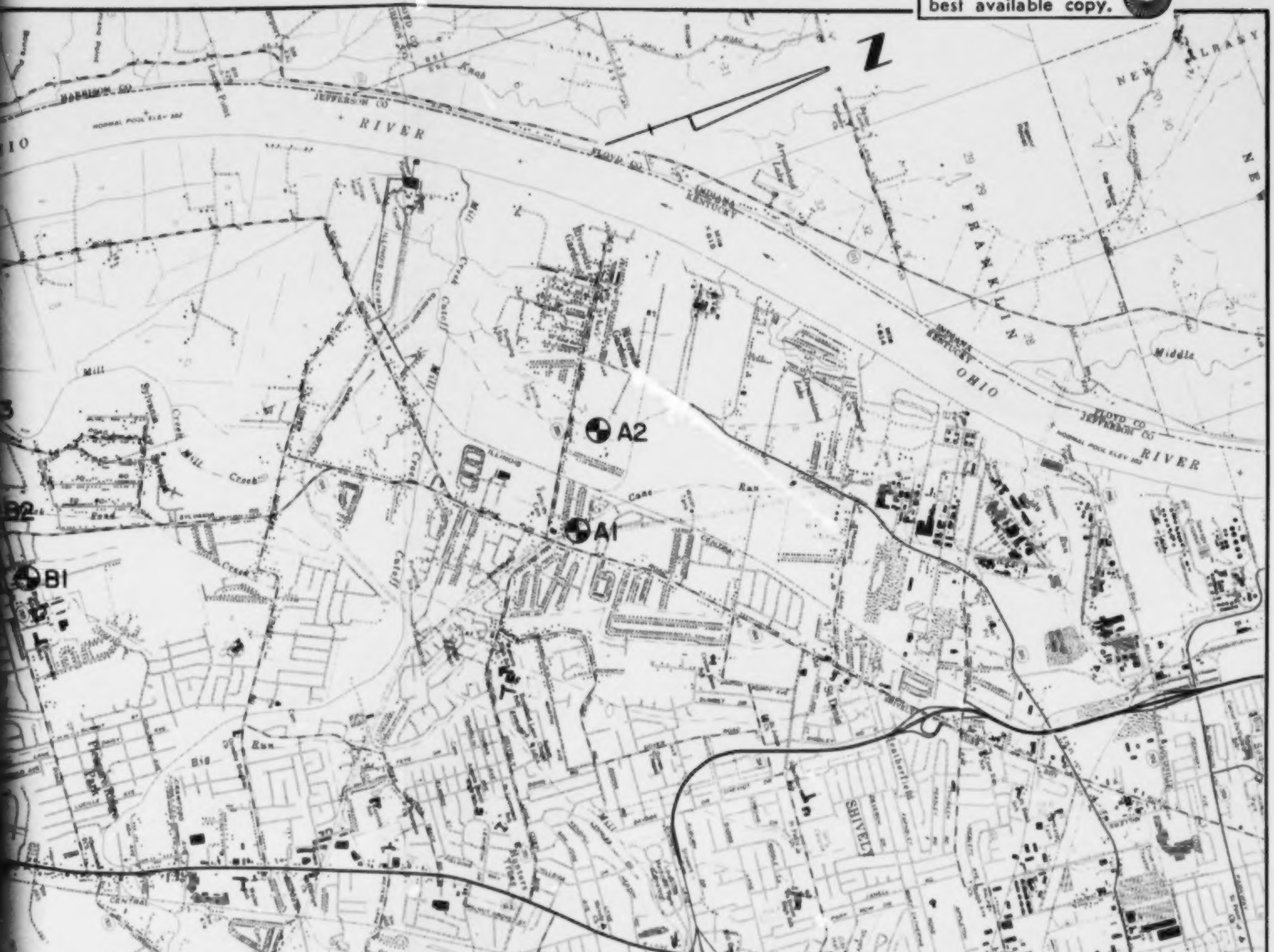

OHIO RIVER
JEFFERSON CO
FLOYD CO
INDIANA
KENTUCKY
FRANKLIN
NEW ALBANY
Middle
A2
A1
B1
B2
Mill Creek
Mill Creek Cutoff
Cane Run
Big Run
SHIVELY
Red Stone Hill
IROQUOIS PARK
4,000 FEET
0
4,000
8,000
1,200 METERS
0
1,200
2,400

FIGURE 5
MILL CREEK
ENVIRONMENTAL IMPACT STATEMENT
JEFFERSON COUNTY, KENTUCKY

MONITORING SITES

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

19.

4.8

Well sites B-1, B-2, and B-3 were established along Greenwood Road. Land use between sites B-1, B-2, and B-3 is single-family residential. All three well sites consist of three separate wells (B-1-s, B-1-m, B-1-d, B-2-s, B-2-m, B-2-d, B-3-s, B-3-m, B-3-d).

Well sites C-1, C-2, C-3, C-4, and C-5 were established along an east-west line represented by Johnsontown Road and its projection eastward from Dixie Highway. Site C-1 is the easternmost sampling position in the study area. Depth to bedrock was found to be relatively shallow, and only one well (C-1) was established. Site C-2 consists of two wells (C-2-s, C-2-d) established just to the east of Dixie Highway. Land use between site C-1 and C-2 is largely undeveloped. Residential development, as it exists, is served by sanitary sewers. Well site C-3, established in the easement of the "600" tributary at Johnsontown Road, consists of three wells (C-3-s, C-3-m, C-3-d). Site C-4, at Black Pond Creek and Johnsontown Road, also consists of three wells (C-4-s, C-4-m, C-4-d). Land use between sites C-2, C-3, and C-4 is predominantly single-family residential. Well site C-5 consists of three wells (C-5-s, C-5-m, C-5-d) at Mill Creek and Johnsontown Road. Land use between sites C-4 and C-5 is generally undeveloped or agricultural.

Well sites D-1 and D-2 each consist of three wells (D-1-s, D-1-m, D-1-d, D-2-s, D-2-m, D-2-d), established to intercept groundwater up and down-gradient from the single-family residential area (Valley Downs subdivision) between the sites.

The southernmost sampling site, E-1, consists of three wells (E-1-s, E-1-m, E-1-d) established at Orell Road and Old Orell Road.

4.2.3 Sampling Well Construction

Wells were constructed by 6½ in. (16.5 cm) diameter hollow-stem auger drilling with a truck-mounted drilling apparatus. At each well site, drilling proceeded to refusal (bedrock). The deep well was placed by extending 2-in. (5.1 cm) diameter PVC piping, with attached well screen, through the hollow stem and pulling the auger out of the ground, leaving the well casing in place. The second, shallow well was placed in a similar manner, with the screen positioned 3m (10 ft.) below the groundwater table observed at the time of drilling. The third well was placed midway between the deep and shallow well. Well tops were finished with bentonite clay and concrete and capped with locking, watertight covers, as shown in Figure 6.

Classification of soil materials was carried out by visual analysis of auger borings carried to the ground surface during the drilling process. These classifications and depths to bedrock for each of the 36 wells are illustrated in Figures 7 through 19. The well top elevations for all A, B, C, and D group wells are provided on Table 2. Well top elevations for E group wells were not determined with respect to mean sea level due to lack of a documented benchmark within a reasonable distance.

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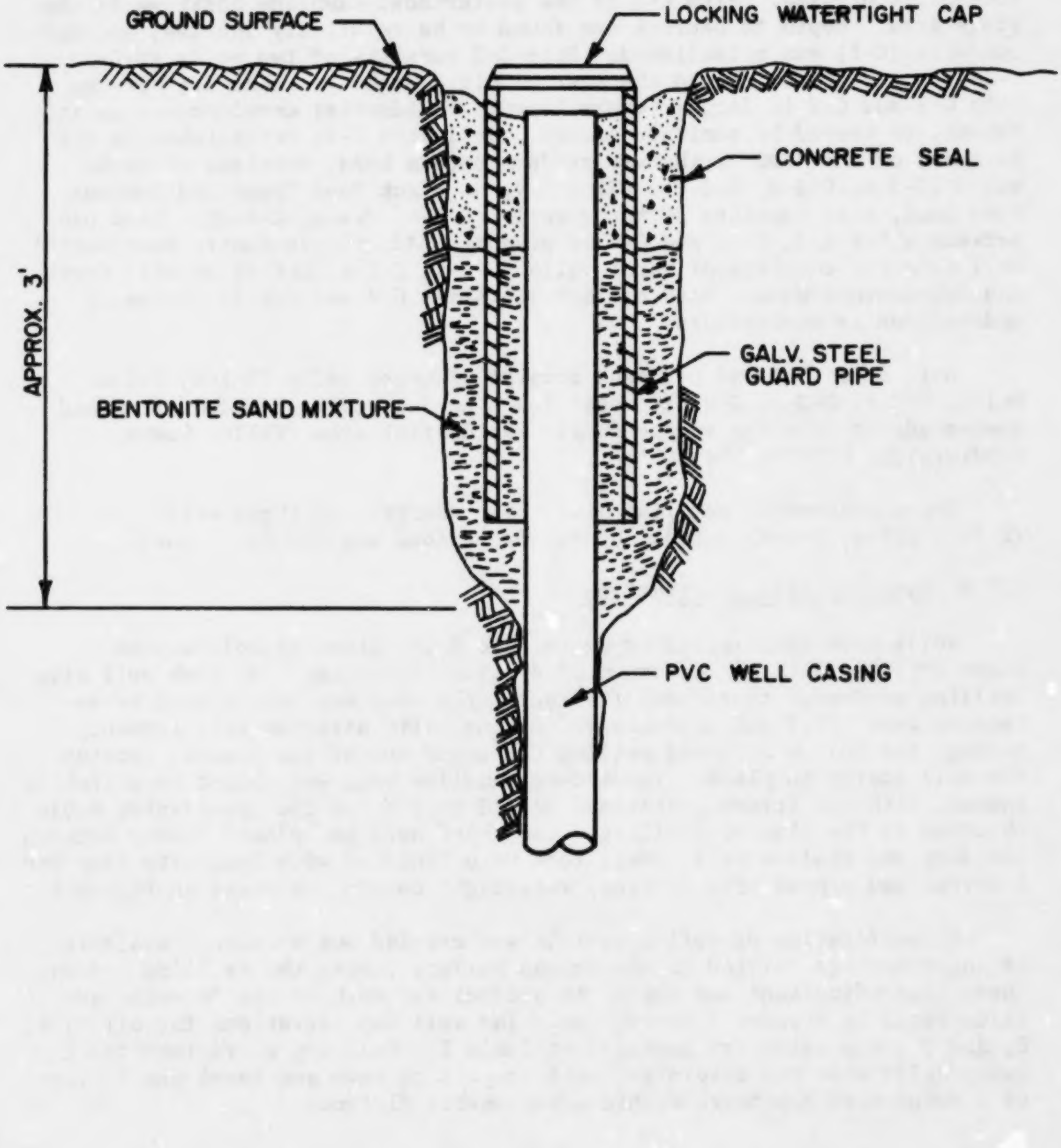
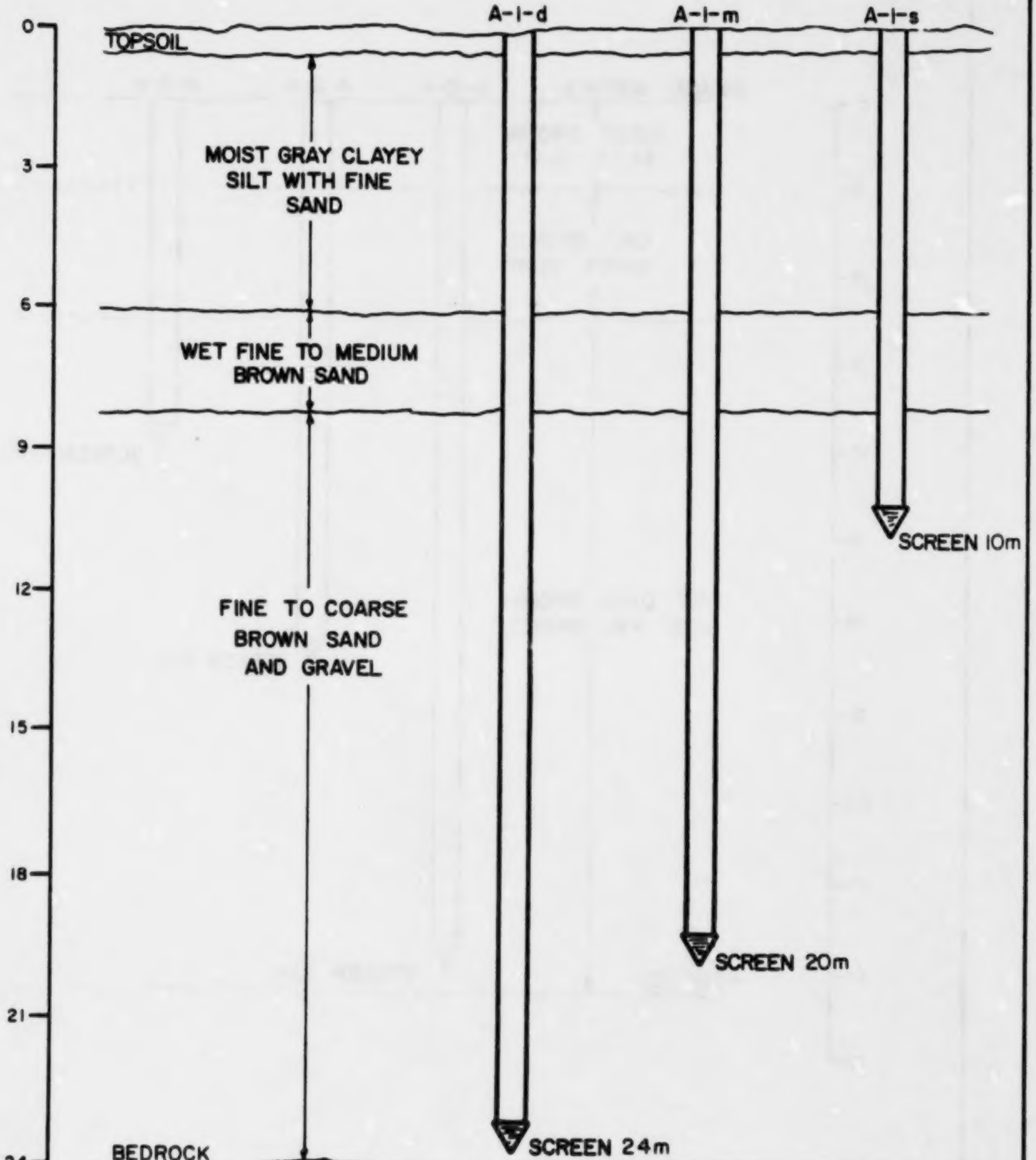

GROUND SURFACE
LOCKING WATERTIGHT CAP
CONCRETE SEAL
APPROX. 3'
GALV. STEEL GUARD PIPE
BENTONITE SAND MIXTURE
PVC WELL CASING

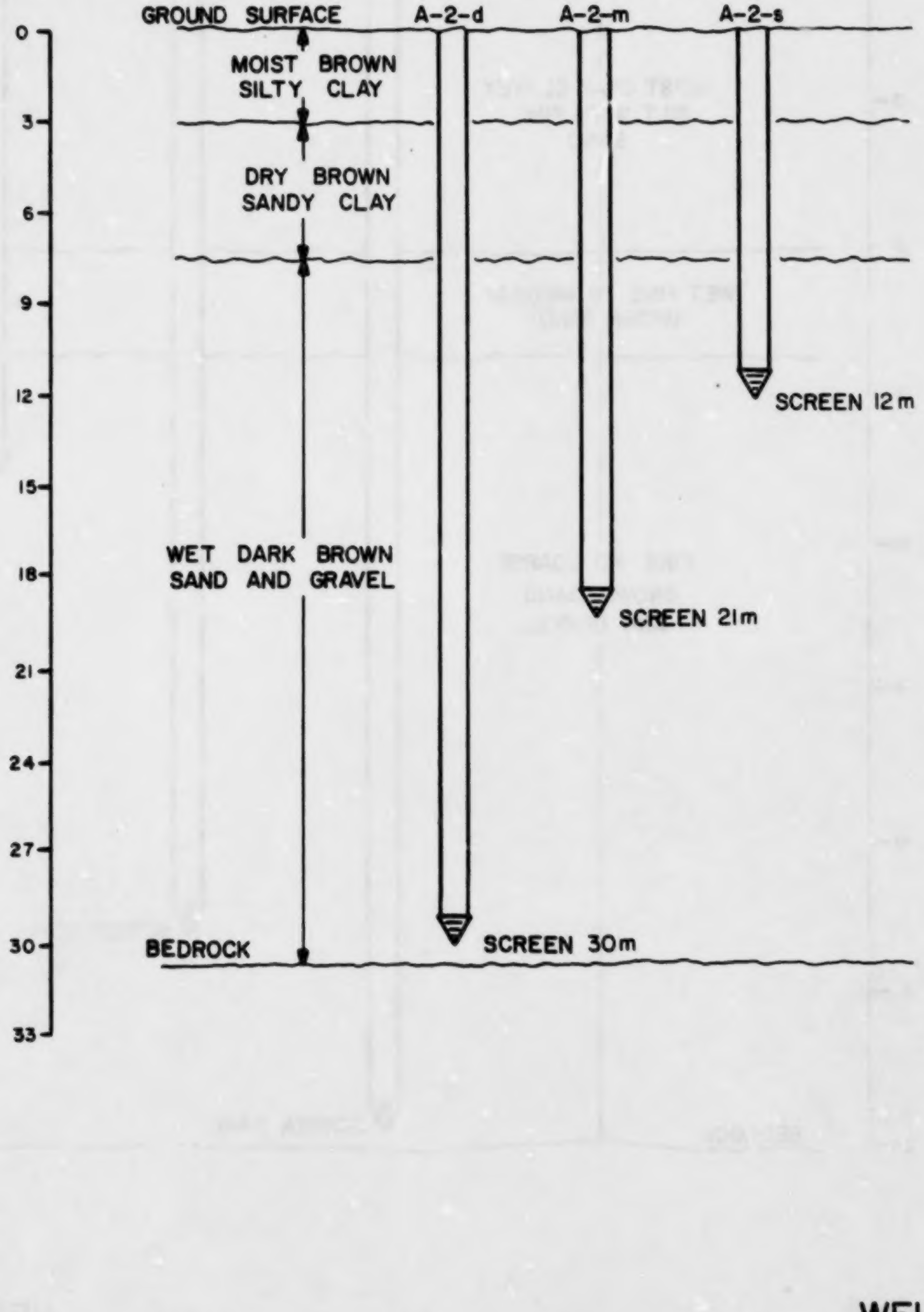
TYPICAL SAMPLING
WELL FINISHING

FIGURE 6


A-1-d
A-1-m
A-1-s
0
3
6
9
12
15
18
21
24
TOPSOIL
MOIST GRAY CLAYEY SILT WITH FINE SAND
WET FINE TO MEDIUM BROWN SAND
FINE TO COARSE BROWN SAND AND GRAVEL
SCREEN 10m
SCREEN 20m
SCREEN 24m
BEDROCK

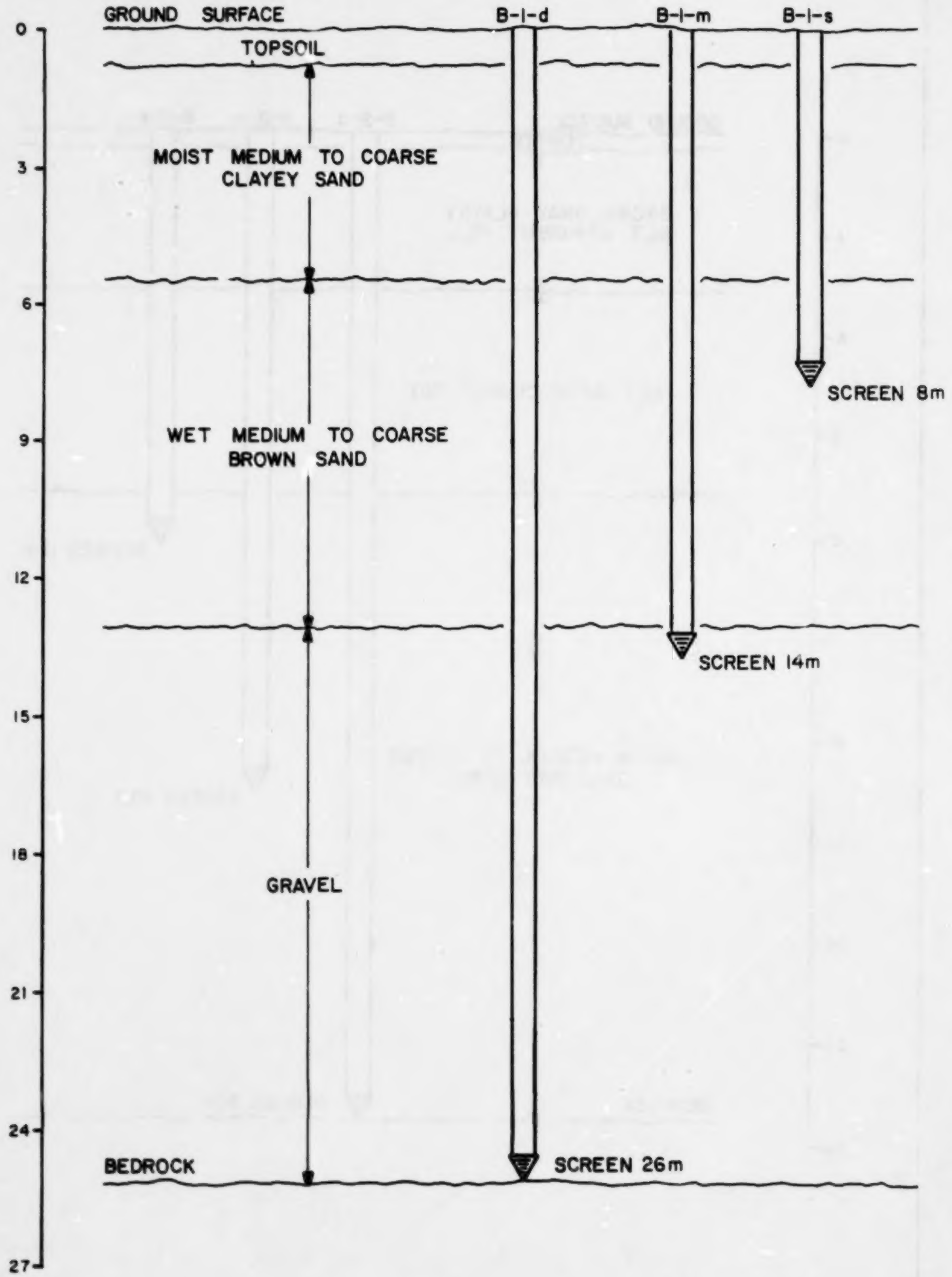
WELL A-1

FIGURE 7


GROUND SURFACE
A-2-d
A-2-m
A-2-s
0
3
6
9
12
15
18
21
24
27
30
33
MOIST BROWN SILTY CLAY
DRY BROWN SANDY CLAY
WET DARK BROWN SAND AND GRAVEL
SCREEN 12 m
SCREEN 21 m
SCREEN 30 m
BEDROCK

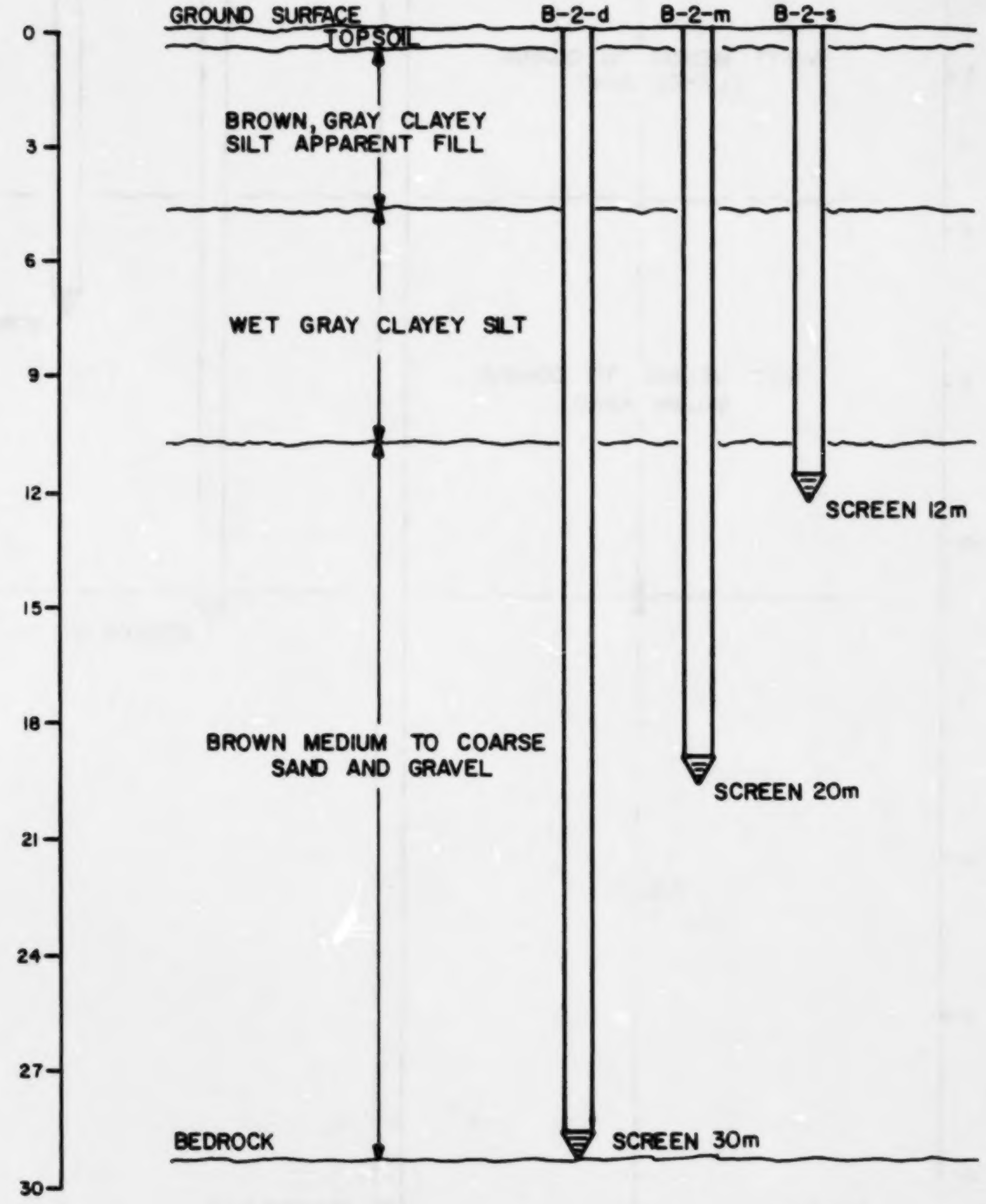
WELL A-2

FIGUR


GROUND SURFACE
B-1-d
B-1-m
B-1-s
TOPSOIL
MOIST MEDIUM TO COARSE CLAYEY SAND
WET MEDIUM TO COARSE BROWN SAND
GRAVEL
BEDROCK
SCREEN 8m
SCREEN 14m
SCREEN 26m
0
3
6
9
12
15
18
21
24
27

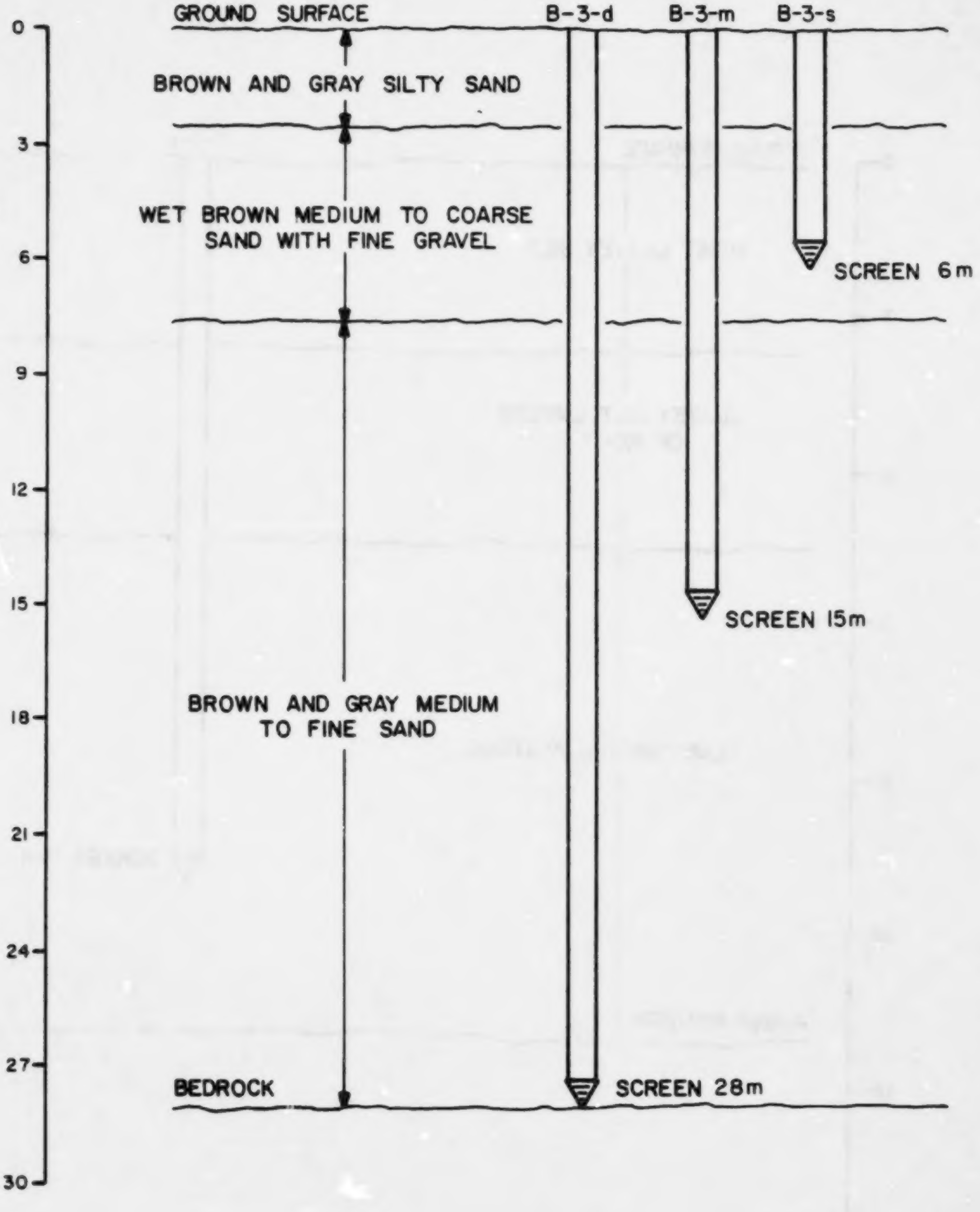
WELL B-1

FIGURE 9


GROUND SURFACE
TOPSOIL
B-2-d
B-2-m
B-2-s
BROWN, GRAY CLAYEY SILT APPARENT FILL
WET GRAY CLAYEY SILT
BROWN MEDIUM TO COARSE SAND AND GRAVEL
BEDROCK
SCREEN 12m
SCREEN 20m
SCREEN 30m
0
3
6
9
12
15
18
21
24
27
30

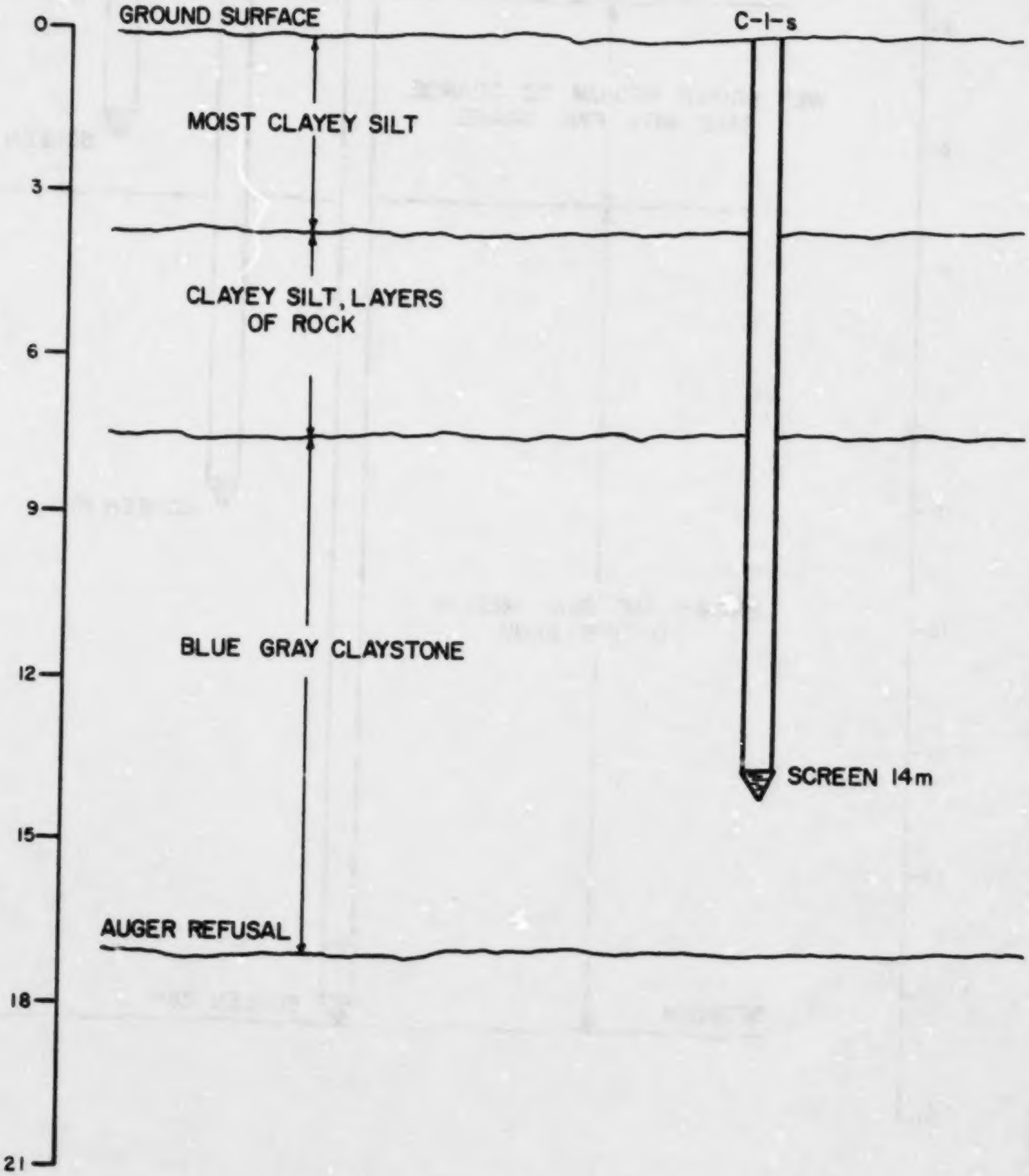
WELL B-2

FIGURE


GROUND SURFACE
B-3-d
B-3-m
B-3-s
BROWN AND GRAY SILTY SAND
WET BROWN MEDIUM TO COARSE SAND WITH FINE GRAVEL
SCREEN 6 m
SCREEN 15m
BROWN AND GRAY MEDIUM TO FINE SAND
BEDROCK
SCREEN 28m
0
3
6
9
12
15
18
21
24
27
30

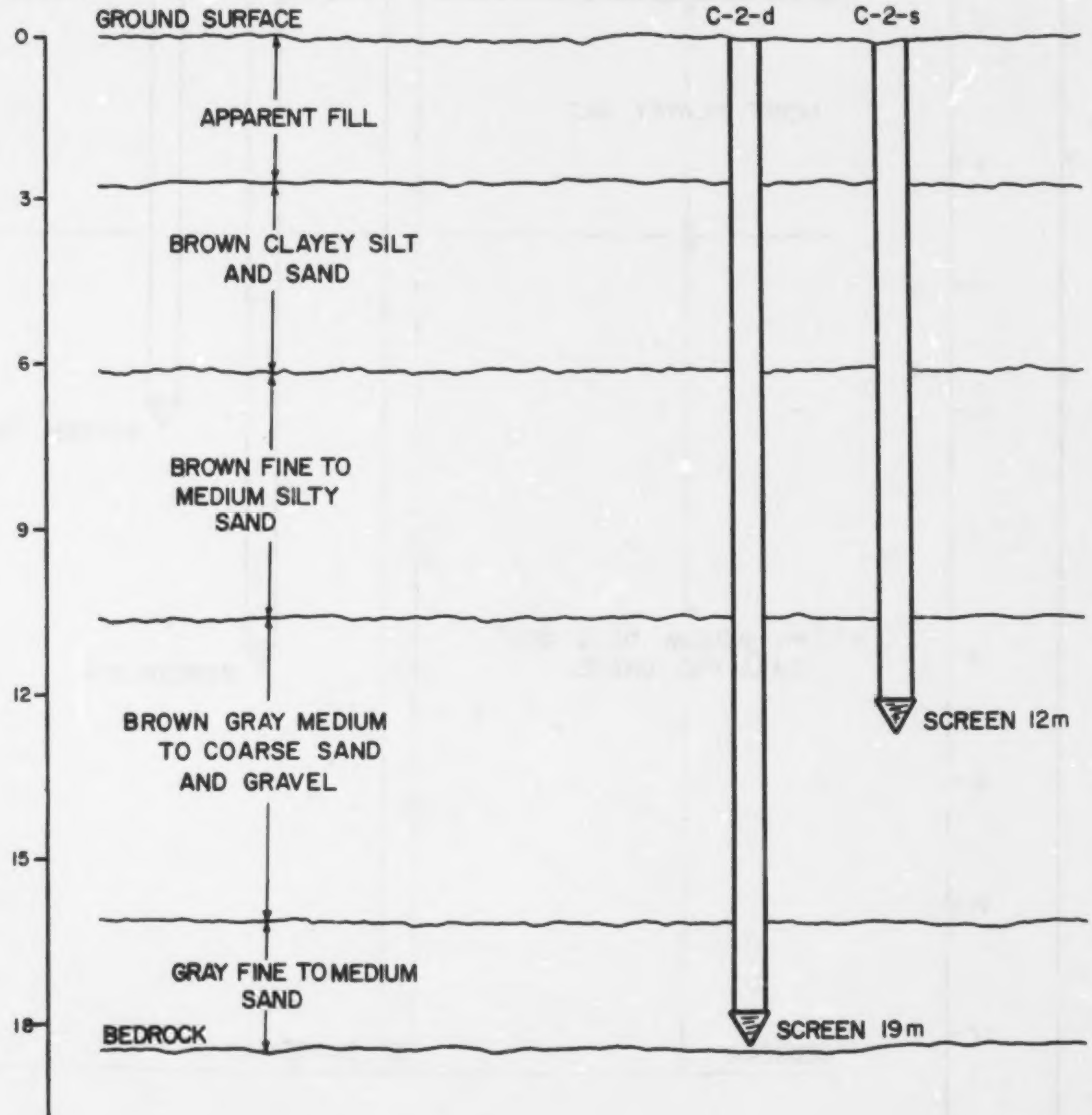
WELL B-3

FIGURE 11


0
3
6
9
12
15
18
21
GROUND SURFACE
C-1-s
MOIST CLAYEY SILT
CLAYEY SILT, LAYERS OF ROCK
BLUE GRAY CLAYSTONE
SCREEN 14m
AUGER REFUSAL

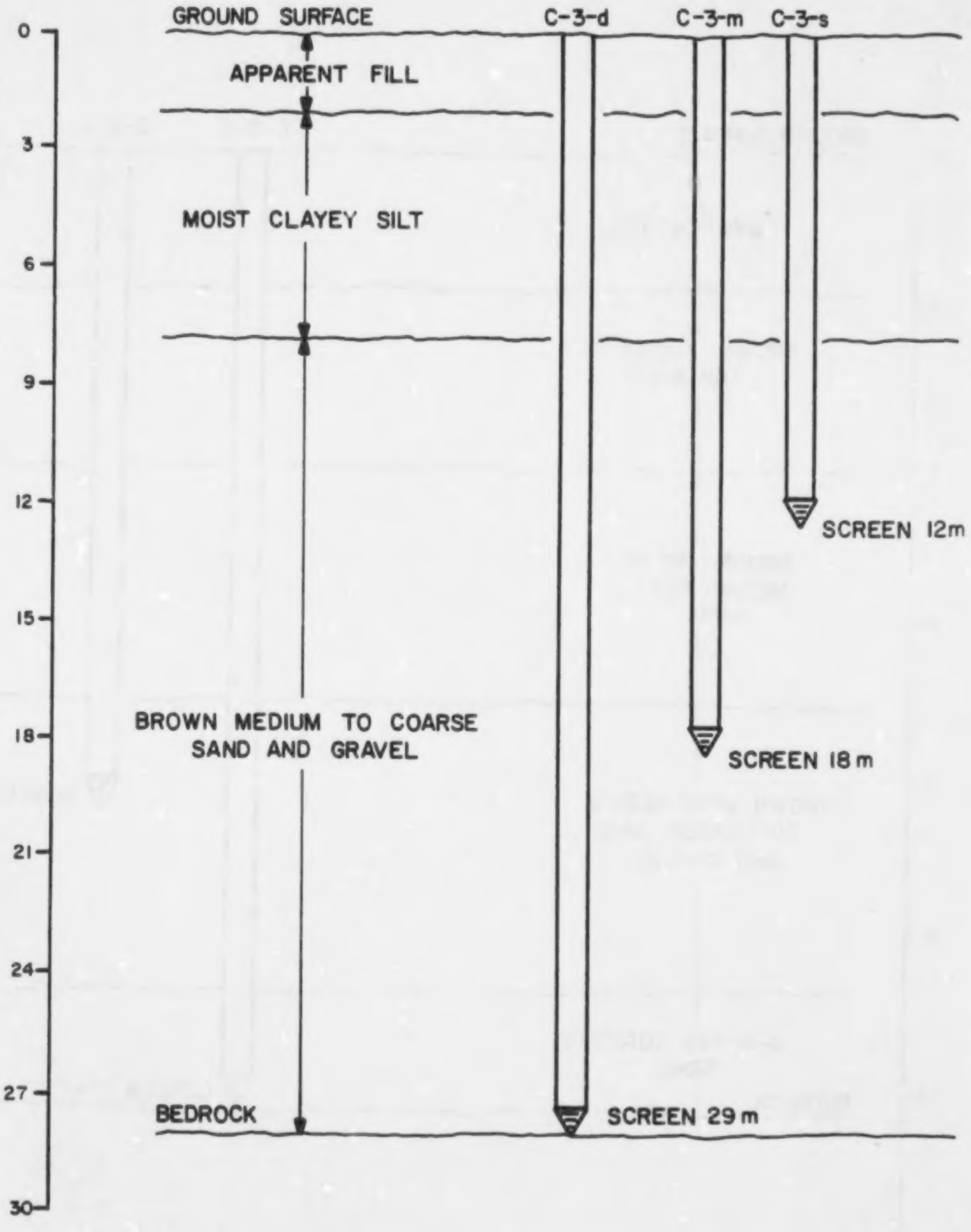
WELL C-1

FIGUR


GROUND SURFACE
C-2-d
C-2-s
0
APPARENT FILL
3
BROWN CLAYEY SILT AND SAND
6
BROWN FINE TO MEDIUM SILTY SAND
9
12
BROWN GRAY MEDIUM TO COARSE SAND AND GRAVEL
SCREEN 12m
15
GRAY FINE TO MEDIUM SAND
18
BEDROCK
SCREEN 19m
21

WELL C-2

FIGURE 13


GROUND SURFACE
C-3-d
C-3-m
C-3-s
APPARENT FILL
MOIST CLAYEY SILT
BROWN MEDIUM TO COARSE SAND AND GRAVEL
BEDROCK
SCREEN 12m
SCREEN 18 m
SCREEN 29 m
0
3
6
9
12
15
18
21
24
27
30

WELL C-3

FIGURE

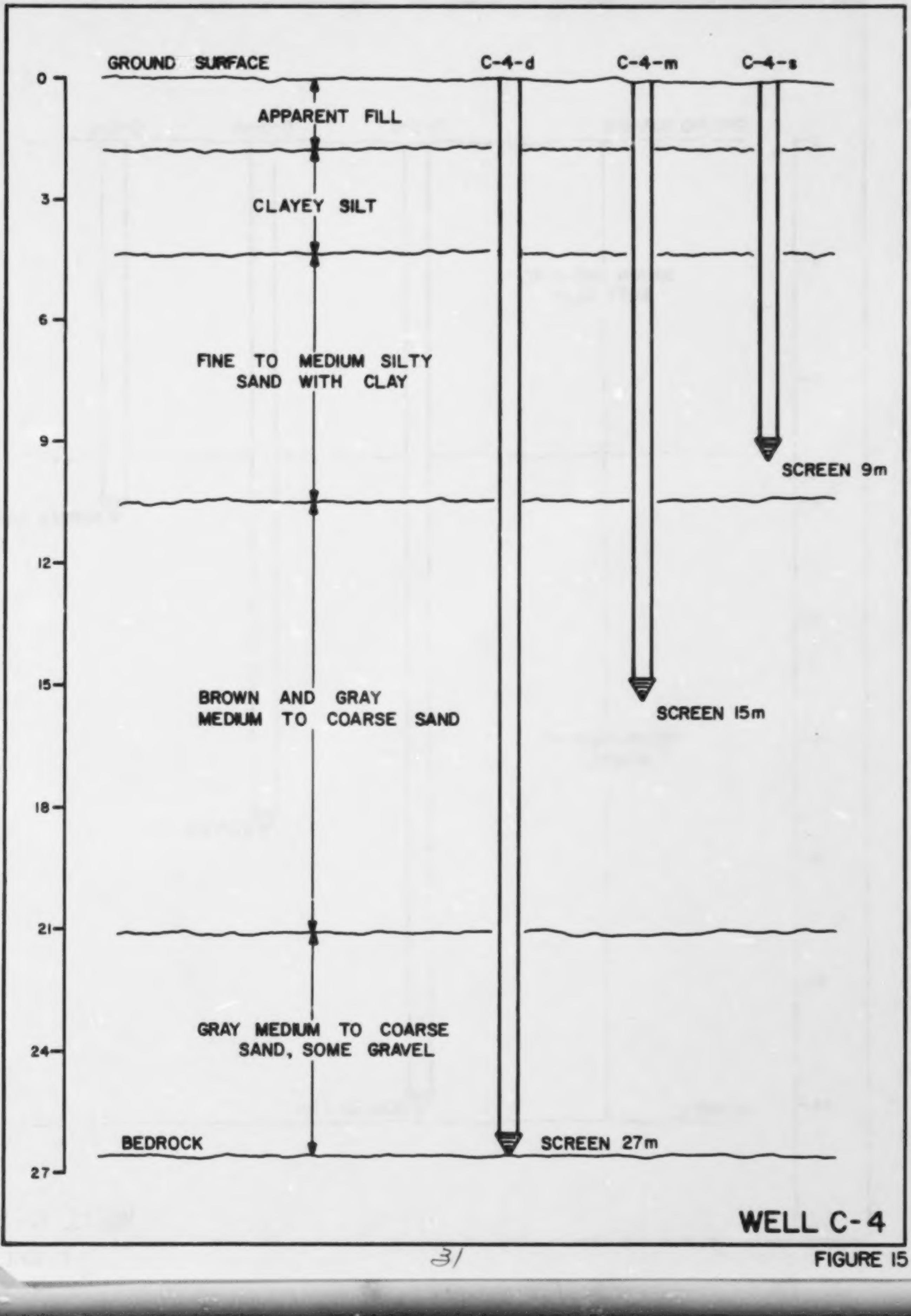
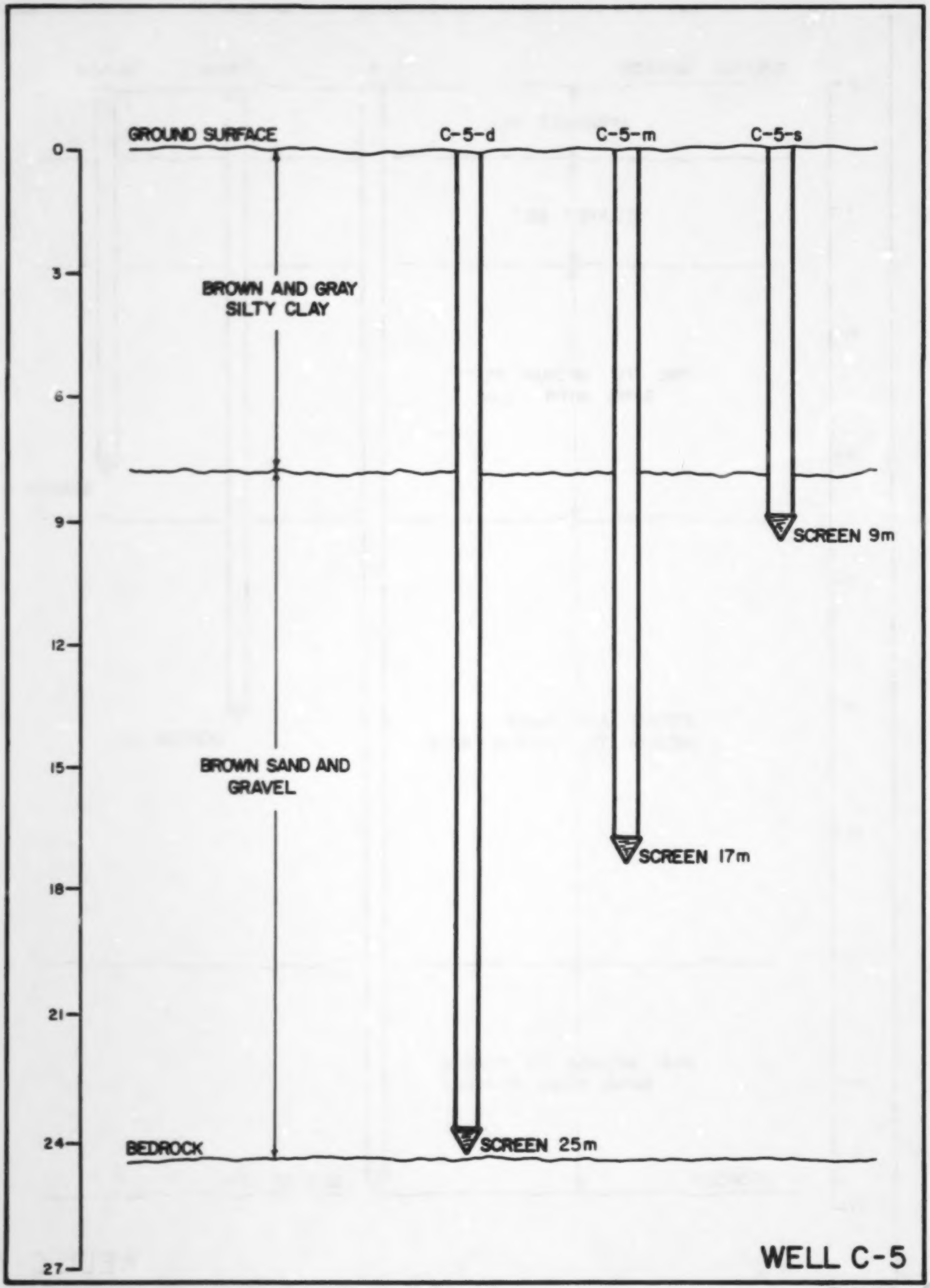
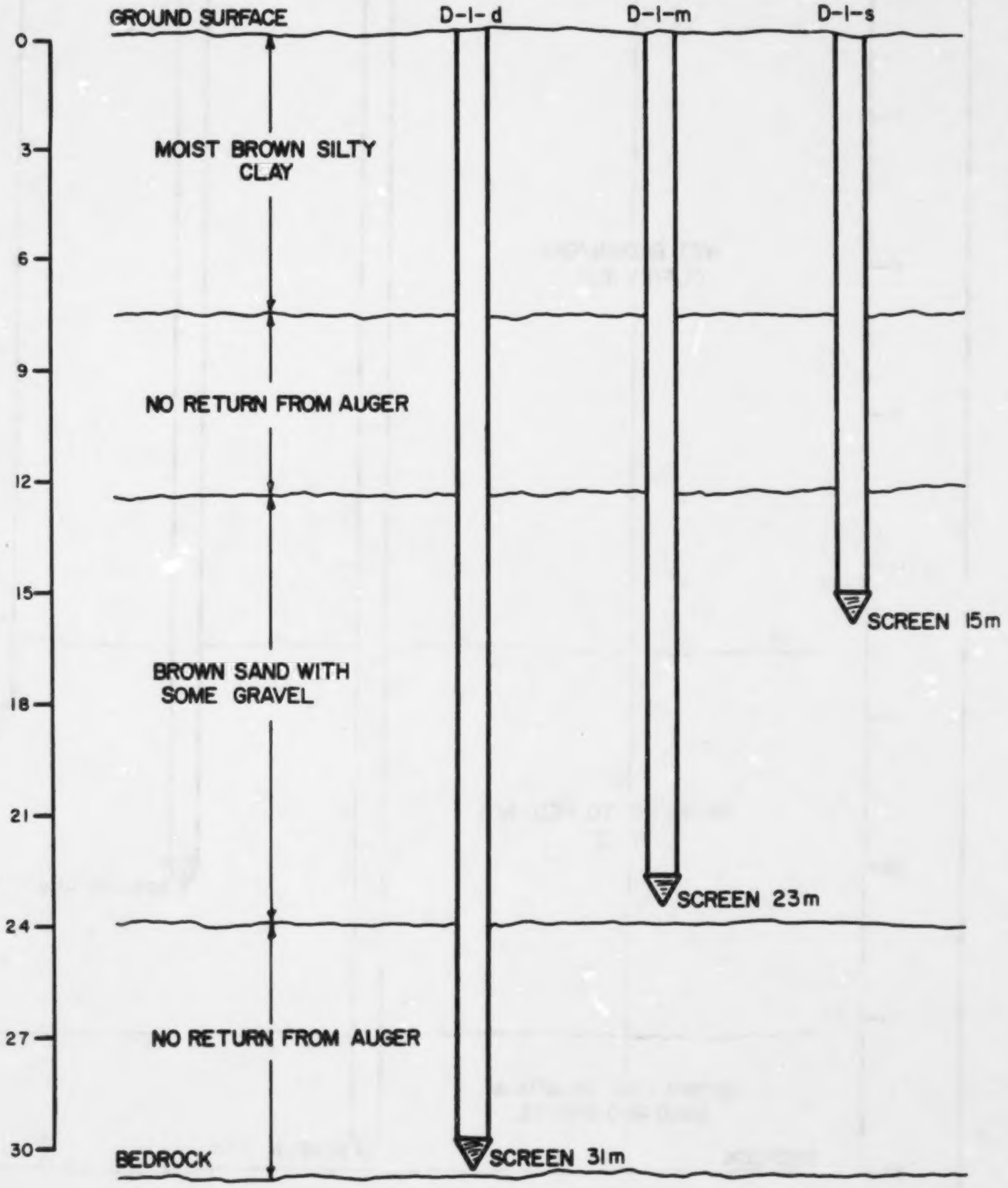

GROUND SURFACE
C-4-d
C-4-m
C-4-s
0
3
6
9
12
15
18
21
24
27
APPARENT FILL
CLAYEY SILT
FINE TO MEDIUM SILTY SAND WITH CLAY
SCREEN 9m
BROWN AND GRAY MEDIUM TO COARSE SAND
SCREEN 15m
GRAY MEDIUM TO COARSE SAND, SOME GRAVEL
BEDROCK
SCREEN 27m
WELL C-4

FIGURE 15


GROUND SURFACE
C-5-d
C-5-m
C-5-s
0
3
6
9
12
15
18
21
24
27
BROWN AND GRAY SILTY CLAY
BROWN SAND AND GRAVEL
SCREEN 9m
SCREEN 17m
SCREEN 25m
BEDROCK

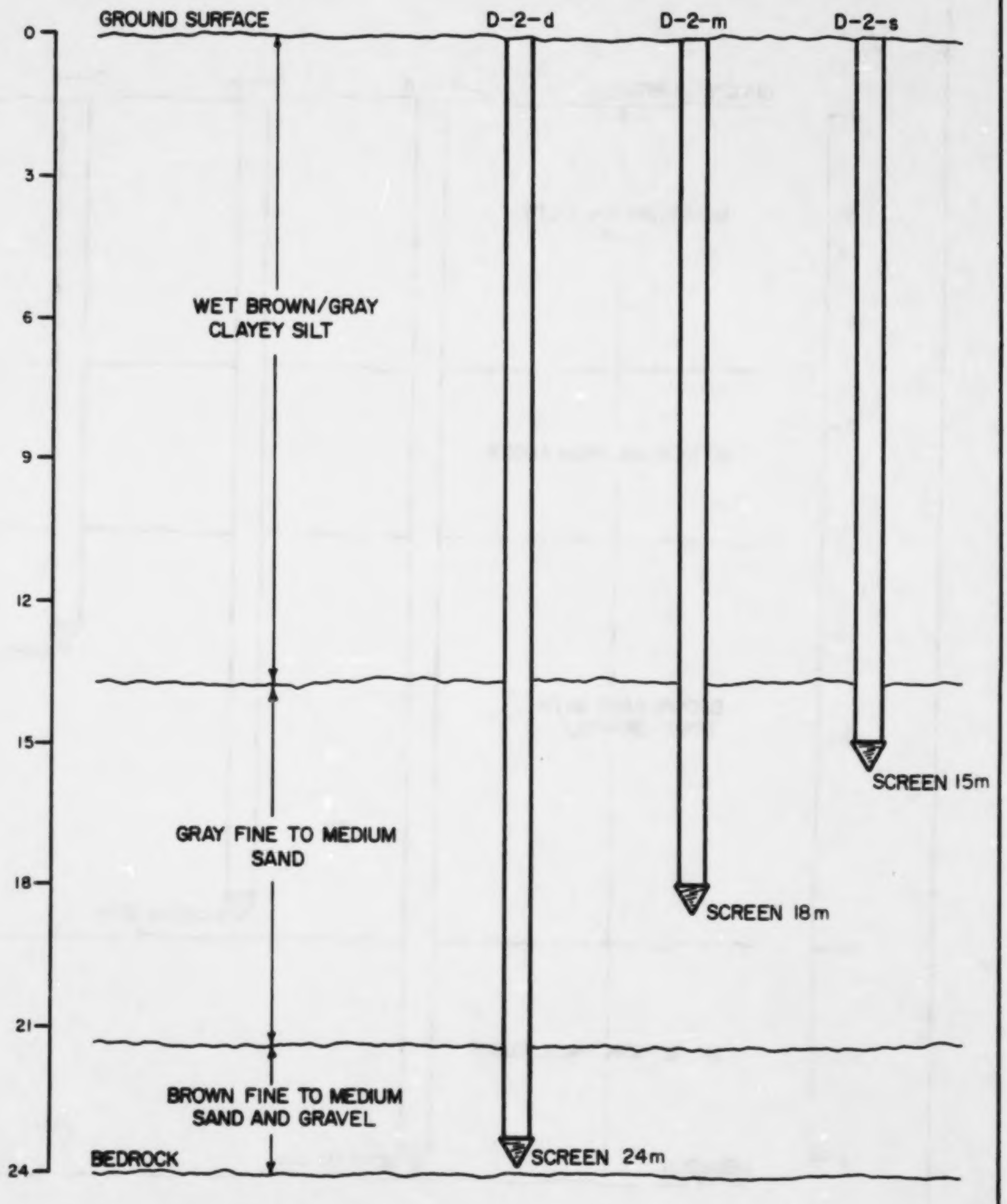
WELL C-5

FIGURE


GROUND SURFACE
D-1-d
D-1-m
D-1-s
0
3
6
9
12
15
18
21
24
27
30
MOIST BROWN SILTY CLAY
NO RETURN FROM AUGER
BROWN SAND WITH SOME GRAVEL
NO RETURN FROM AUGER
BEDROCK
SCREEN 15m
SCREEN 23m
SCREEN 31m

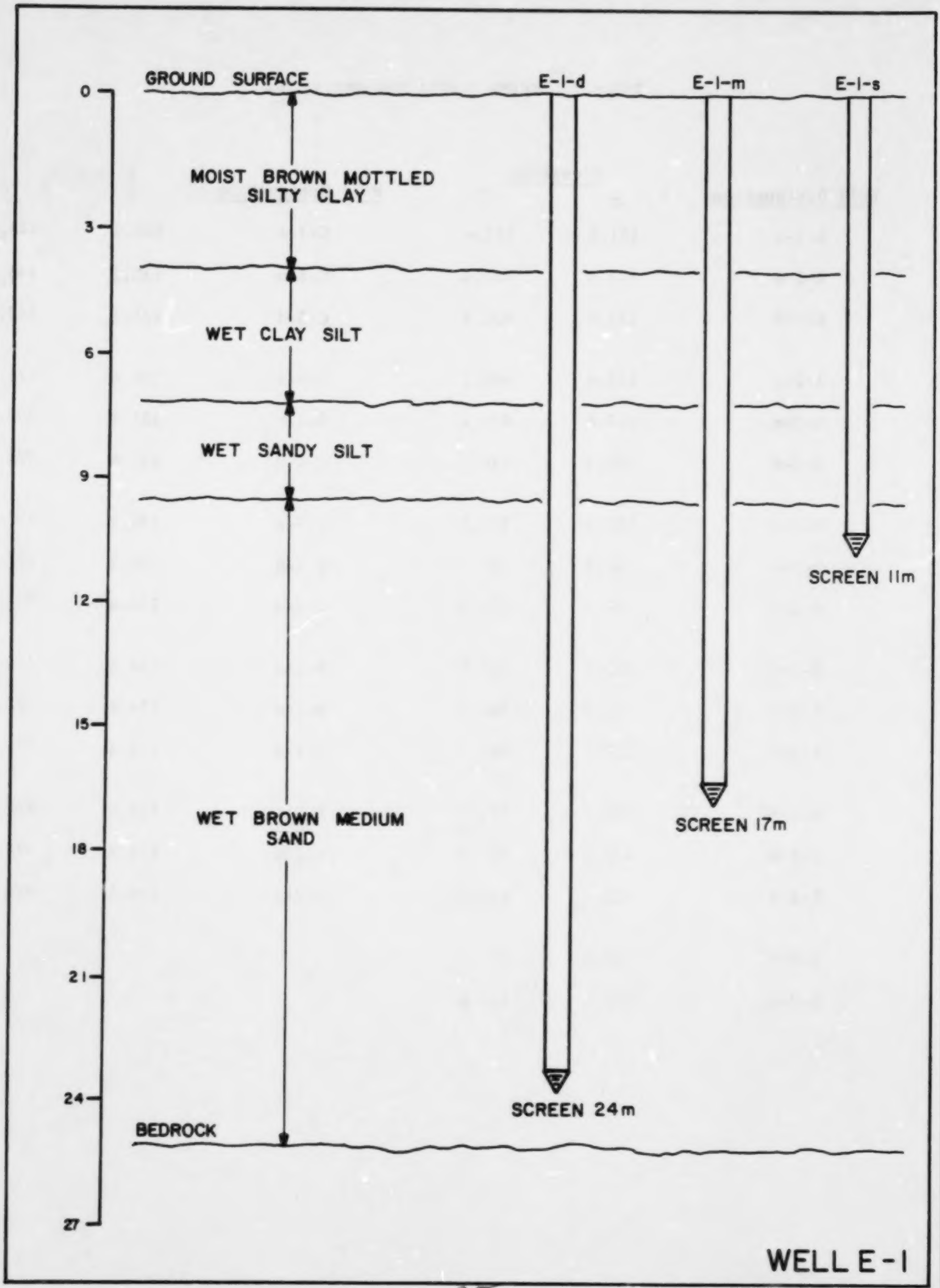
WELL D-1

FIGURE 17


GROUND SURFACE
D-2-d
D-2-m
D-2-s
0
3
6
9
12
15
18
21
24
WET BROWN/GRAY CLAYEY SILT
GRAY FINE TO MEDIUM SAND
BROWN FINE TO MEDIUM SAND AND GRAVEL
BEDROCK
SCREEN 15m
SCREEN 18m
SCREEN 24m

WELL D-2

FIGURE


GROUND SURFACE
E-1-d
E-1-m
E-1-s
0
3
6
9
12
15
18
21
24
27
MOIST BROWN MOTTLED SILTY CLAY
WET CLAY SILT
WET SANDY SILT
WET BROWN MEDIUM SAND
SCREEN 11m
SCREEN 17m
SCREEN 24m
BEDROCK
WELL E-1

35

FIGURE 19

TABLE 2. PHASE 2 WELL TOP ELEVATIONS

	Elevation	
Well Designation	m	ft
A-1-s	131.8	432.4
A-1-m	131.8	432.4
A-1-d	131.8	432.4
A-2-s	133.8	439.1
A-2-m	133.8	439.1
A-2-d	133.8	439.1
B-1-s	137.5	451.2
B-1-m	137.5	451.2
B-1-d	137.6	451.3
B-2-s	135.2	443.5
B-2-m	135.2	443.5
B-2-d	135.2	443.4
B-3-s	129.4	424.7
B-3-m	129.5	424.9
B-3-d	129.5	424.9
C-2-s	141.0	462.5
C-2-d	141.1	462.8
C-3-s	135.1	443.2
C-3-m	135.1	443.1
C-3-d	135.1	443.3
C-4-s	131.6	431.8
C-4-m	131.7	432.1
C-4-d	131.8	432.5
C-5-s	130.2	427.0
C-5-m	130.2	427.1
C-5-d	130.2	427.1
D-1-s	134.3	440.5
D-1-m	134.4	440.9
D-1-d	134.4	441.1
D-2-s	129.5	424.9
D-2-m	129.3	424.3
D-2-d	129.3	424.2

4.3 SAMPLING PROGRAM

4.3.1 Sampling Equipment

The two in. (5.1 cm) diameter of the PVC well casing precluded the use of a high-rate submersible well pump. Several other sampling options using commercially available equipment were considered and rejected. A pump at ground level with a suction line extended down the well casing would have been limited to a groundwater depth of about 9m(30 ft). Several wells were expected to exhibit water table depths below 9m. A tube or bottle sampler would be operable at any depth expected in this program, but such a sampling routine would not draw water into the well casing from the aquifer, but would simply obtain samples from inside the casing. After consultation with the Louisville District U. S. Geological Survey, the project team obtained a custom-made, gas-driven, positive displacement bladder pump from a manufacturer in New Albany, Indiana (Tole Devices, Inc.). The pump was constructed of stainless steel, with a silicone bladder and food-grade plastic tubing. A schematic diagram of the pump and a brief description of its operation is provided in Figure 20.

4.3.2 Sampling Protocol

The sampling period occurred from August, 1979, through July 1980. Samples were obtained during this period for three different analytical programs. Samples were drawn from each well about once each month for "routine analysis". Groundwater constituents assayed in the routine analysis are listed in Table 3. Samples from five of the 36 wells were analyzed each month for Federal Interim Primary Drinking Water Standards (IPDWS), as prescribed by the Safe Drinking Water Act of 1974, through the first six sampling events. IPDWS are listed on Table 4. Finally, samples from a total of four different wells were analyzed for EPA "priority pollutant" constituents, listed on Table 5. A composite schedule of sampling from each well is presented on Table 6.

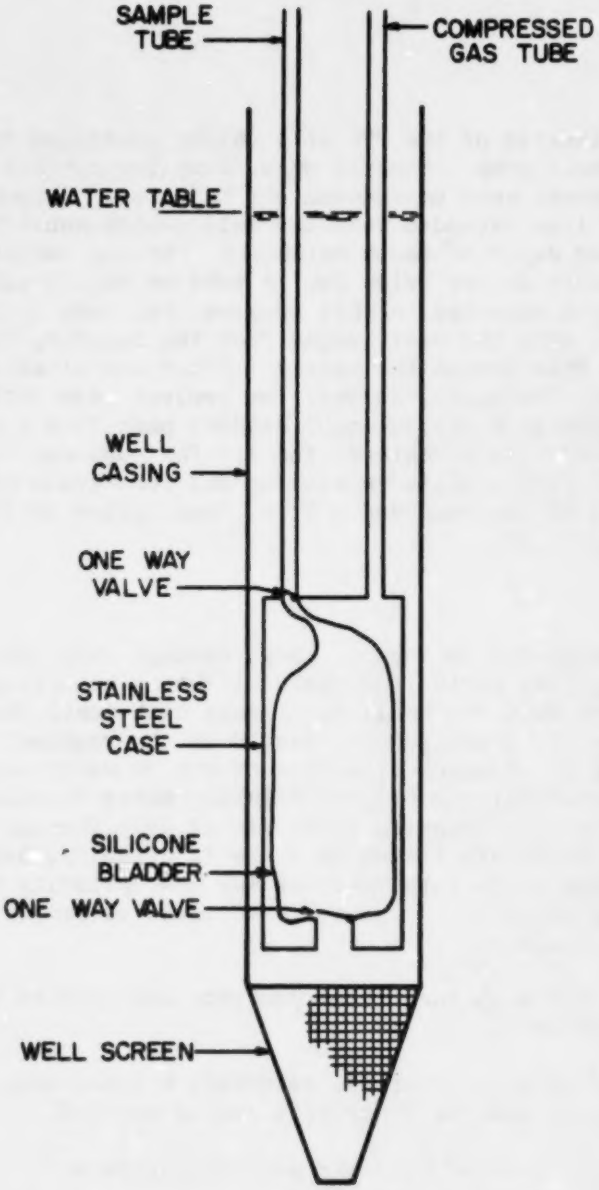
Sampling of each well, for each analytical program, was carried out according to the following protocol:

1. Soil around the locked well cover was carefully brushed away, the cover was removed, and the inner well casing exposed.

2. The sampling pump was lowered into the well casing to a position at the well screen.

3. The pump was activated and allowed to discharge to waste for a period of 30 mintes.

4. Samples were placed in appropriate containers and packed for shipment according to the detailed sample handling routine described in Appendix A.


SAMPLE TUBE
COMPRESSED GAS TUBE
WATER TABLE
WELL CASING
ONE WAY VALVE
STAINLESS STEEL CASE
SILICONE BLADDER
ONE WAY VALVE
WELL SCREEN

OPERATION:

1. WATER SAMPLE FLOWS INTO SILICONE BLADDER UNDER HYDROSTATIC PRESSURE
2. COMPRESSED GAS "SQUEEZES" SILICONE BLADDER, FORCING WATER SAMPLE UP SAMPLE TUBE

SAMPLING PUMP DETAIL

FIGURE

TABLE 3. GROUNDWATER CONSTITUENTS ANALYZED IN "ROUTINE ANALYSIS"

Nitrate nitrogen
Chloride
Fluoride
Fecal coliform
Methylene blue active substances (MBAS)

Note: MBAS is a nonspecific assay of surface active agents found in synthetic household detergents.

TABLE 4. INTERIM PRIMARY DRINKING WATER STANDARD (IPDWS) CONSTITUENTS

I. Inorganic constituents

- Arsenic
- Barium
- Cadmium
- Chromium
- Lead
- Mercury
- Nitrate nitrogen
- Selenium
- Silver

II. Pesticides, herbicides

- Endrin
- Lindane
- Methoxychlor
- Toxaphene
- 2, 4-D
- 2, 4, 5 - TP Silvex

TABLE 5. EPA "PRIORITY POLLUTANTS"

Chlorinated Alkanes
Methyl Chloride
Methylene Chloride
Methyl Bromide
Chloroform
Bromoform
Carbon Tetrachloride
Dichlorobromomethane
Trichlorofluoromethane
Dichlorodifluromethane
Chlorodibromomethane
Chloroethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1,1-Trichloroethane
1,1,2-Trichloroethane
1,1,2,2-Tetrachloroethane
Hexachloroethane
1,1-Dichloroethylene
1,2-trans-Dichloroethylene
1,2-Dichloropropane
1,2-Dichloropropylene
Trichloroethylene
Tetrachloroethylene
Vinyl Chloride
Hexachlorobutadlene
Hexachlorocyclopentadlene

Chlorinated Aromatics
1,2,4-Trichlorobenzene
Chlorobenzene
Hexachlorobenzene
2-Chloronaphthalene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene

Chlorinated Ethers
bis(Chloromethyl Ether
2-Chloroethyl Vinyl Ether
4-Bromophenyl Phenyl Ether
bis(2-Chloroethoxy) Methane
bis(2-Chloroethyl) Ether
4-Chlorophenyl Phenyl Ether
bis(2-Chloroisopropyl) Ether

Aromatics
Benzene
Toluene
Ethylbenzene
Naphthalene
Fluoranthene
Acenaphthene
Benzo(a) Anthracene
Benzo(a) Pyrene
Chrysene
Indeno(1,2,3-c,d)pyrene
3,4-Benzofluoranthene
Benzo(K)fluoranthene
Acenaphthylene
Anthracene
Benzo(ghi)perylene
Fluorene
Phenanthene
Dibenzo(a,h)anthracene
Pyrene

Phthalate Esters
bis(2-ethylhexyl)phthalate
Butyl Benzyl Phthalate
Di-n-butyl Phthalate
Di-n-octyl Phthalate
Diethyl Phthalate
Dimethyl Phthalate

Phenols
Phenol
2-Chlorophenol
2,4-Dichlorophenol
Pentachlorophenol
2-Nitrophenol
2,4-Dimethylphenol
4-Nitrophenol
2,4-Dinitrophenol
4,6-Dinitro-o-cresol
2,4,6-Trichlorophenol
para-Chloro-meta-Cresol

Substituted Aromatics
Nitrobenzene
2,4-Dinitrotoluene
2,6-Dinitrotoluene
2,3,7,8-Tetrachlorodibenzo-p-Dioxin
Benzidine
3,3-Dichlorobenzidene
1,2-Diphenyl Hydrazine

Polychlorinated Biphenyls
PCB-1242 PCB-1221 PCB-1260
PCB-1254 PCB-1232 PCB-1016
PCB-1248

Miscellaneous
Acrolein
Acrylonitrile
Asbestos
Cyanide
Isophorone
N-Nitrosodimethylamine
N-Nitrosodiphenylamine
N-Nitrosodi-n-propylamine

Pesticides
Aldrin
Dieldrin
Chlordane
4,4-DDT
4,4-DDE
4,4-DDD
a-Endosulfan-alpha
b-Endosulfan-beta
Endosulfan Sulfate
Endrin
Endrin Aldehyde
Heptachlor
Heptachlor Epoxide
e-BHC - Alpha
b-BHC - Beta
r-BHC(Lindane)-Gamma
g-BHC - Delta
Toxaphene

Metals
Antimony
Arsenic
Beryllium
Cadmium
Chromium
Copper
Lead
Mercury
Nickel
Selenium
Silver
Thallium
Zinc

TABLE 6. COMPOSITE GROUNDWATER SAMPLING AND ANALYSIS SCHEDULE

Well Designation	Sampling event 1	2	3	4	5	6	7	8	9	10	11	12
A-1-s	R	R	R	R	R	R	R	R	R	R	R	R
A-1-m	R	R	R	R	R	R	R	R	R	R	R	R
A-1-d	R	R	R	R	R	R	R	R	R	R	R	R
A-2-s	R,I	R,I,P	R,I	R,I,P	R,I	R,I,P	R	R	R	R	R	R
A-2-m	R	R	R	R	R	R	R	R	R	R	R	R
A-2-d	R	R	R	R	R	R	R,I	R,P	R	R	R	R
B-1-s	D	D	D	D	D	D	D	D	D	D	D	D
B-1-m	R	R	R	R	R	R	R	R	R	R	R	R
B-1-d	R	R	R	R	R	R	R	R	R	R	R	R
B-2-s	R,I	R,I,P	R,I	R,I	R,I	R,I	R	R	R	R	R	R
B-2-m	R	R	R	R	R	R	R	R	R	R	R	R
B-2-d	R	R	R	R	R	R	R,I	R	R	R	R	R
B-3-s	R	D	R	R	R	R	R	R	R	R	R	R
B-3-m	R	R	R	R	R	R	R	R	R	R	R	R
B-3-d	R	R	R	R	R	R	R	R	R	R	R	R
C-1	R	R	R	R	R	R	R	R	R	D	D	D
C-2-s	D	D	D	D	D	D	D	D	D	D	D	D
C-2-d	R	R	R	R	R	R	R,I	R	R	R	R	R
C-3-s	R,I	R,I	R,I	R,I,P	R,I	R,I	R	R	R	R	R	R
C-3-m	R	R	R	R	R	R	R	R	R	R	R	R
C-3-d	R	R	R	R	R	R	R	R	R	R	R	R
C-4-s	R	R	R	R	R	R	R	R	R	R	R	R
C-4-m	R	R	R	R	R	R	R	R	R	R	R	R
C-4-d	R	R	R	R	R	R	R	R	R	R	R	R
C-5-s	R	R	R	R	R	R	R	R	R	R	R	R
C-5-m	R	R	R	R	R	R	R	R	R	R	R	R
C-5-d	R	R	R	R	R	R	R	R	R	R	R	R
D-1-s	R	R	R	R	R	R	R	R	R	R	R	R
D-1-m	R	R	R	R	R	R	R	R	R	R	R	R
D-1-d	R	R	R	R	R	R	R	R	R	R	R	R
D-2-s	R,I	R,I	R,I	R,I	R,I	R,I,P	R	R	R	R	R	R
D-2-m	R	R	R	R	R	R	R	R	R	R	R	R
D-2-d	R	R	R	R	R	R	R,I	R	R	R	R	R

TABLE 6. (CONT.)

Well Designation	1	2	3	4	5	6	7	8	9	10	11	12
E-1-s	R,I	R,I	R,I	D	R,I	R,I	R	R	R	R	R	R
E-1-m	R	R	R	R	R	R	R	R	R	R	R	R
E-1-d	R	R	R	R	R	R	R,I	R	R	R	R	R

Notes:
R - "routine analysis" parameters
I - Interim Primary Drinking Waters Standards
P - "priority pollutant" parameters
D - Dry well at time of sampling

5. Sampling for "priority pollutant" analysis was carried out in conformance with Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants, U. S. EPA, Environmental Monitoring and Support Laboratory, April 1977 (revised).

6. At the end of a sampling day, the pump and tubing was rinsed by pumping clean tap water through the equipment for about 30 mintues.

7. Following each sampling period (about once each month) the pump and tubing was disinfected with a dilute hypochlorite solution, and rinsed with tap water.

4.4 ANALYTICAL PROGRAM

4.4.1 Analytical Protocol--Routine Analyses

Analytical methods for routine groundwater parameters are described below:

1. Fecal coliforms were assayed in duplicate by membrane filtration (0.45-um filters) using M-FC broth. Incubation for 24 hours at 44.5°C.

2. MBAS was determined by chloroform extraction and colorimetric measurement after reaction of extract with methylene blue, as described in Standard Methods for the Examination of Water and Wastewater (Standard Methods) Method 512A.

3. Fluoride was determined by using Orion Model 94-09A specific ion electrode according to manufacturer's instructions.

4. Chloride was determined by using Orion Model 94-17A specific ion electrode according to manufacturer's instructions.

5. Nitrate was determined by (1) brucine colorimetric method (Standard Methods) Method 419D or (2) by using Orion Model 93-07 specific ion electrode according to manufacturer's instructions.

4.4.2 Analytical Protocol - IPDWS

Interim Primary Drinking Water Standards were determined as described below:

1. Barium, cadmium, chromium, lead, silver were assayed by nitric acid/hydrochloric acid digestion followed by flame atomic absorption spectrophotometry (Varian Model 375 BQ).

2. Mercury was determined by cold vapor generation (Varian Model M-65 Vapor generation accessory) on Varian Model 375 BQ.

3. Arsenic and selenium were determined by gaseous hydride generation (Varian Model M-64) on Varian Model 375 BQ.

4. Pesticides and herbicides were assayed by the Carborundum Company laboratory in Sacramento, California. Analyses were performed in conformance with protocol outlined in Methods for Organochlorine Pesticides in Industrial Effluents, MDQARL, EPA, November 20, 1973, and Methods for Chlorinated Phenoxy Acid Herbicides in Industrial Effluents, MDQARL, EPA, November 28, 1973.

4.4.3 Analytical Protocol - "Priority Pollutants"

Samples for "priority pollutant" assay were shipped by air freight to the Carborundum Company laboratory in Sacramento, California. Analytical methods were carried out in conformance with protocol outlined in Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants, EMSL, EPA, April 1977.

4.5 RESULTS AND DISCUSSION

4.5.1 Routine Measurements and Analyses

The record of groundwater level measurements and results of laboratory analyses for routine parameters (nitrate, chloride, fluoride, MBAS, and fecal coliform) are provided on Tables 7 through 18. It is important to note that the twelve sampling events constitute discrete points in time, separated by about one month each. Thus, the results should not be considered to constitute a continuous record of groundwater conditions. Day to day changes in groundwater quality which may have occurred between sampling events cannot be characterized under the Phase 2 program.

Groundwater level

Groundwater level observations exhibited a general increase in water table depth between the first and second sampling events. Groundwater levels generally remained fairly constant throughout the sampling program. Examination of precipitation records for the Standiford Field station of the U. S. Weather Bureau did not reveal an obvious correlation between precipitation and groundwater depth.

Nitrate nitrogen

Throughout the study area, the range of values for nitrate was 0.09 mg/l as N to 17.7 mg/l as N. The U. S. EPA Interim Primary Drinking Water Standard for nitrate in finished drinking water is 10.0 mg/l as N. Eleven samples

TABLE 7. RESULTS FROM THE FIRST SAMPLING, PHASE 2

Well I.D.	Date	Depth to water table (m)	Nitrate-N (mg/1)	Chloride (mg/1)	Fluoride (mg/1)	MBAS (mg/1)	Fecal coliform (number/100 ml)
A-1-s	8/27/79	5.7	5.9	27	0.27	ND	30
A-1-m	8/27/79	5.7	2.9	46	0.89	TR	300
A-1-d	8/27/79	5.7	2.8	46	0.98	TR	400
A-2-s	8/27/79	7.0	5.2	74	0.13	TR	60
A-2-m	8/27/79	7.0	1.8	50	0.20	ND	600
A-2-d	8/27/79	7.0	3.5	44	1.0	TR	0
B-1-s	- - D R	Y	- - - W E	L L	- - -	- - -	- - -
B-1-m	8/28/79	8.5	11	24	0.29	ND	20
B-1-d	8/28/79	8.5	3.0	44	1.1	TR	50
B-2-s	8/28/79	7.0	13	64	0.14	TR	0
B-2-m	8/28/79	7.0	0.80	29	0.13	ND	0
B-2-d	8/28/79	7.0	.91	25	0.82	TR	0
B-3-s	9/4/79	3.4	1.6	39	0.22	TR	60
B-3-m	9/4/79	3.4	0.28	28	0.20	TR	10
B-3-d	9/4/79	3.4	0.38	14	0.33	TR	0
C-1-s	8/29/79	NR	1.48	590	0.41	TR	0
C-2-s	- - D R	Y	- - - W E	L L	- - -	- - -	- - -
C-2-d	8/29/79	12.2	0.48	9.7	0.22	ND	0
C-3-s	8/29/79	6.4	6.0	5.6	0.29	TR	0
C-3-m	8/29/79	6.4	0.46	45	0.23	ND	0
C-3-d	8/29/79	6.4	0.91	19	0.11	ND	0
C-4-s	8/29/79	4.6	4.2	34	0.12	ND	0
C-4-m	8/29/79	4.6	0.50	34	0.10	ND	0
C-4-d	8/29/79	4.6	0.68	31	0.58	ND	0
C-5-s	8/28/79	NR	0.97	36	0.81	TR	20
C-5-m	8/28/79	NR	1.1	36	0.81	TR	8
C-5-d	8/28/79	NR	1.2	36	0.85	TR	5
D-1-s	8/30/79	6.7	0.23	25	0.085	ND	10
D-1-m	8/30/79	6.7	0.32	25	0.36	ND	20
D-1-d	8/30/79	6.7	0.32	9.3	0.11	TR	30
D-2-s	9/4/79	NR	0.84	34	0.18	TR	100
D-2-m	9/4/79	NR	0.56	8.4	0.18	TR	2000
D-2-d	9/4/79	NR	1.6	39	0.22	TR	50
E-1-s	8/30/79	NR	7.4	30	0.11	ND	10
E-1-m	8/30/79	NR	0.39	30	0.11	ND	180
E-1-d	8/30/79	NR	0.50	49	0.13	ND	360

Note: NR = Not Recorded
ND = None Detected
TR = Trace

TABLE 8. RESULTS FROM THE SECOND SAMPLING, PHASE 2

Well I.D.	Date	Depth to water table (m)	Nitrate-N (mg/1)	Chloride (mg/1)	Fluoride (mg/1)	MBAS (mg/1)	Fecal coliform (number/100 ml)
A-1-s	9/24/79	6.9	3.4	31	0.23	TR	25
A-1-m	9/24/79	6.9	0.26	39	0.72	TR	7
A-1-d	9/24/79	6.9	0.22	42	0.11	TR	12
A-2-s	9/24/79	9.1	7.3	54	0.24	TR	40
A-2-m	9/24/79	9.1	0.24	52	0.20	TR	10
A-2-d	9/24/79	9.1	0.21	39	0.28	TR	0
B-1-s	- D R	Y - - - - - -	W E	L L	- - - - -	- - - - -	- - - - -
B-1-m	10/1/79	8.5	6.1	32	0.21	ND	4
B-1-d	10/1/79	8.5	0.26	38	0.22	TR	75
B-2-s	10/1/79	8.5	9.8	75	0.10	TR	9
B-2-m	10/1/79	7.6	0.23	27	0.13	TR	0
B-2-d	10/1/79	7.6	0.30	27	0.94	TR	6
B-3-s	- D R	Y - - - - - -	W E	L L	- - - - -	- - - - -	- - - - -
B-3-m	10/3/79	3.7	0.27	29	0.70	TR	280
B-3-d	10/3/79	3.7	0.32	43	0.93	TR	28
C-1-s	10/2/79	NR	0.78	461	0.38	ND	0
C-2-s	- D R	Y - - - - - -	W E	L L	- - - - -	- - - - -	- - - - -
C-2-d	10/1/79	12.2	0.19	9.3	0.17	TR	200
C-3-s	9/26/79	7.3	3.5	58	0.31	TR	0
C-3-m	9/26/79	7.3	0.25	48	0.28	TR	52
C-3-d	9/26/79	7.3	0.28	20	0.20	TR	1
C-4-s	9/26/79	4.9	4.4	30	0.13	ND	0
C-4-m	9/26/79	4.9	0.32	37	0.95	TR	6
C-4-d	9/26/79	4.9	0.27	23	0.29	TR	5
C-5-s	9/26/79	4.9	4.5	22	0.16	TR	0
C-5-m	9/26/79	4.9	0.34	33	0.74	TR	45
C-5-d	9/26/79	4.9	0.45	22	0.25	TR	12
D-1-s	10/2/79	7.3	0.27	31	0.11	ND	0
D-1-m	10/2/79	7.3	0.27	18	0.30	TR	2
D-1-d	10/2/79	7.3	0.29	31	0.80	TR	38
D-2-s	10/3/79	4.0	0.58	34	0.67	0.025	18000
D-2-m	10/3/79	4.0	0.30	21	0.19	TR	30
D-2-d	10/3/79	4.0	0.34	37	0.68	TR	270
E-1-s	10/3/79	NR	11	40	0.26	ND	32
E-1-m	10/3/79	NR	0.41	27	0.23	ND	22
E-1-d	10/3/79	NR	0.23	50	0.30	TR	26

Note: NR = Not Recorded
ND = None Detected
TR = Trace

TABLE 9. RESULTS FROM THE THIRD SAMPLING, PHASE 2

Well I.D.	Date	Depth to water table (m)	Nitrate-N (mg/1)	Chloride (mg/1)	Fluoride (mg/1)	MBAS (mg/1)	Fecal coliform (number/100 ml)
A-1-s	10/23/79	6.7	1.9	32	0.26	TR	4
A-1-m	10/23/79	6.7	0.11	45	1.2	TR	60
A-1-d	10/23/79	6.7	0.09	31	0.22	TR	200
A-2-s	10/23/79	9.1	9.3	65	0.20	ND	50
A-2-m	10/23/79	9.1	0.09	52	0.27	TR	35
A-2-d	10/23/79	9.1	0.09	34	0.15	TR	10
B-1-s	-D R	Y - - - - -	W E	L L	- - -	- - -	- - -
B-1-m	10/22/79	7.9	8.3	32	0.19	TR	70
B-1-d	10/22/79	7.9	0.11	39	0.26	TR	220
B-2-s	10/22/79	6.7	0.12	17	0.33	TR	190
B-2-m	10/22/79	6.7	0.12	27	0.18	TR	23
B-2-d	10/22/79	6.7	0.14	30	0.95	TR	20
B-3-s	10/22/79	3.0	0.15	42	0.23	0.030	220
B-3-m	10/22/79	3.0	0.11	37	0.15	TR	17
B-3-d	10/22/79	3.0	0.13	28	0.39	0.030	18
C-1-s	10/24/79	NR	0.32	315	0.37	TR	40
C-2-s	- D R	Y - - - - -	W E	L L	- - -	- - -	- - -
C-2-d	10/24/79	11.6	0.09	8.7	0.13	TR	27
C-3-s	10/25/79	6.4	5.2	67	0.30	TR	90
C-3-m	10/25/79	6.4	0.12	38	0.74	TR	60
C-3-d	10/25/79	6.4	0.13	30	0.95	0.025	2500
C-4-s	10/24/79	4.3	5.3	32	0.12	TR	10
C-4-m	10/24/79	4.3	0.14	40	0.27	TR	65
C-4-d	10/24/79	4.3	0.14	43	1.1	0.068	150
C-5-s	10/24/79	3.4	4.1	22	0.22	TR	0
C-5-m	10/24/79	3.4	0.18	27	0.22	0.020	25
C-5-d	10/24/79	3.4	0.17	28	0.25	0.028	70
D-1-s	10/25/79	6.1	0.13	20	0.13	TR	18
D-1-m	10/25/79	6.1	0.12	21	0.48	0.025	25
D-1-d	10/25/79	6.1	0.10	12	0.19	0.023	35
D-2-s	10/29/79	2.7	0.62	34	0.71	0.310	7000
D-2-m	10/29/79	2.7	0.21	18	0.16	TR	12
D-2-d	10/29/79	2.7	0.23	36	0.70	0.030	350
E-1-s	10/25/79	NR	13	42	0.22	0.020	15
E-1-m	10/25/79	NR	0.16	29	0.45	0.020	500
E-1-d	10/25/79	NR	0.20	50	0.34	0.023	60

Note: NR = Not Recorded
ND = None Detected
TR = Trace

TABLE 10. RESULTS FROM THE FOURTH SAMPLING, PHASE 2

Well I.D.	Date	Depth to water table (m)	Nitrate-N (mg/1)	Chloride (mg/1)	Fluoride (mg/1)	MBAS (mg/1)	Fecal coliform (number/100 ml)
A-1-s	11/28/79	6.7	2.4	30	0.29	TR	0
A-1-m	11/28/79	6.7	0.14	28	0.18	TR	0
A-1-d	11/28/79	6.7	0.18	28	0.14	TR	0
A-2-s	12/12/79	9.1	8.5	64	0.19	ND	0
A-2-m	11/27/79	9.1	0.14	47	0.16	TR	9
A-2-d	11/27/79	9.1	0.12	33	0.16	TR	0
B-1-s	- D R	Y - - - - - -	W E	L L	- - - - - -	- - - - - -	- - - - - -
B-1-m	11/26/79	9.8	0.70	35	0.28	TR	450
B-1-d	11/26/79	8.5	0.14	34	0.17	TR	25
B-2-s	11/26/79	6.7	1.2	26	0.17	TR	145
B-2-m	11/26/79	6.7	0.16	5.4	0.13	TR	120
B-2-d	11/26/79	6.7	0.13	35	0.12	TR	0
B-3-s	11/28/79	2.7	0.67	47	0.16	ND	25
B-3-m	11/28/79	2.7	0.14	42	0.14	TR	0
B-3-d	11/28/79	2.7	0.11	22	0.12	TR	0
C-1-s	11/26/79	NR	0.35	204	0.40	TR	5
C-2-s	- D R	Y - - - - - -	W E	L L	- - - - - -	- - - - - -	- - - - - -
C-2-d	11/29/79	11.9	0.10	7.5	0.14	ND	60
C-3-s	12/12/79	6.1	4.5	63	0.33	ND	0
C-3-m	11/27/79	6.1	0.13	54	0.31	ND	0
C-3-d	11/27/79	6.1	0.07	20	0.16	TR	0
C-4-s	11/28/79	4.3	5.4	30	0.11	ND	0
C-4-m	11/28/79	4.3	0.43	36	0.13	TR	0
C-4-d	11/28/79	4.3	0.13	22	0.19	ND	0
C-5-s	11/29/79	3.7	4.6	28	0.17	ND	0
C-5-m	11/29/79	3.7	0.17	25	0.20	ND	0
C-5-d	11/29/79	3.7	0.16	17	0.20	ND	10
D-1-s	12/3/79	6.1	0.13	11	0.17	ND	10
D-1-m	12/3/79	6.1	0.13	11	0.17	ND	35
D-1-d	12/3/79	6.1	0.11	11	0.17	ND	40
D-2-s	12/3/79	2.4	0.11	20	0.12	ND	0
D-2-m	12/3/79	2.4	0.13	20	0.12	ND	5
D-2-d	12/3/79	2.4	0.14	30	0.10	ND	40
E-1-s	- D R	Y - - - - - -	W E	L L	- - - - - -	- - - - - -	- - - - - -
E-1-m	11/29/79	6.1	0.14	24	0.24	ND	20
E-1-d	11/29/79	6.1	0.17	49	0.23	TR	0

Note: NR = Not Recorded
ND = None Detected
TR = Trace
NBM = No Benchmark

TABLE 11. RESULTS FROM THE FIFTH SAMPLING, PHASE 2

Well I.D.	Date	Depth to water table (m)	Nitrate-N (mg/1)	Chloride (mg/1)	Fluoride (mg/1)	MBAS (mg/1)	Fecal coliform (number/100 ml)
A-1-s	1/2/80	6.7	5.3	26	0.20	TR	2000
A-1-m	1/2/80	6.7	0.19	24	0.30	TR	0
A-1-d	1/2/80	6.7	0.28	25	0.07	TR	0
A-2-s	1/2/80	9.1	12.0	46	0.12	TR	0
A-2-m	1/2/80	9.1	0.20	36	0.07	TR	800
A-2-d	1/2/80	9.1	0.13	29	0.14	TR	1500
B-1-s	- D R	Y - - - - -	W E	L L	- - - -	- - - -	- - - -
B-1-m	1/2/80	NR	12.8	26	0.10	TR	50
B-1-d	1/2/80	NR	0.14	28	0.06	ND	50
B-2-s	1/3/80	7.0	13.7	64	0.02	TR	0
B-2-m	1/3/80	7.0	0.19	22	0.11	TR	0
B-2-d	1/3/80	7.0	0.13	31	0.05	ND	0
B-3-s	1/3/80	2.4	0.63	30	0.06	TR	580
B-3-m	1/3/80	2.4	0.12	29	0.09	TR	1000
B-3-d	1/3/80	2.4	0.13	21	0.12	TR	0
C-1-s	1/9/80	NR	0.43	142	0.34	TR	0
C-2-s	- D R	Y - - - - -	W E	L L	- - - -	- - - -	- - - -
C-2-d	1/3/80	NR	0.13	10	0.04	ND	50
C-3-s	1/7/80	6.4	3.1	48	0.24	ND	0
C-3-m	1/7/80	6.4	0.17	43	0.20	ND	0
C-3-d	1/7/80	6.4	0.10	16	0.08	ND	0
C-4-s	1/7/80	4.3	1.1	23	0.05	ND	0
C-4-m	1/7/80	4.3	0.17	29	0.05	ND	5
C-4-d	1/7/80	4.3	0.11	19	0.17	ND	0
C-5-s	1/7/80	4.0	4.8	25	0.13	ND	0
C-5-m	1/7/80	4.0	0.15	22	0.12	TR	0
C-5-d	1/7/80	4.0	0.15	16	0.14	TR	0
D-1-s	1/9/80	6.1	0.11	21	0.04	TR	0
D-1-m	1/9/80	6.1	0.08	11	0.11	ND	0
D-1-d	1/9/80	6.1	0.14	11	0.12	ND	0
D-2-s	1/9/80	2.4	0.21	36	0.09	TR	0
D-2-m	1/9/80	2.4	0.13	18	0.05	TR	0
D-2-d	1/9/80	2.4	0.14	26	0.08	TR	0
E-1-s	1/9/80	6.1	16.0	44	0.28	TR	0
E-1-m	1/9/80	6.1	0.15	32	0.15	TR	0
E-1-d	1/9/80	6.4	0.23	37	0.05	ND	0

Note: NR - Not Recorded
ND = None Detected
TR = Trace

TABLE 12. RESULTS FROM THE SIXTH SAMPLING, PHASE 2

Well I.D.	Date	Depth to Water Table (m)	Nitrate-N (mg/1)	Chloride (mg/1)	Fluoride (mg/1)	MBAS (mg/1)	Fecal Coliform (Number/100 ml)
A-1-s	2/21/80	6.9	4.1	27	0.32	ND	0
A-1-m	2/21/80	6.9	0.32	23	0.16	TR	0
A-1-d	2/21/80	6.9	1.1	26	0.18	0.030	12
A-2-s	2/20/80	9.0	7.8	39	0.22	0.021	0
A-2-m	2/20/80	9.0	0.33	39	0.14	0.035	0
A-2-d	2/20/80	9.0	0.35	31	0.17	TR	0
B-1-s	DRY WELL						
B-1-m	2/14/80	8.2	6.7	26	0.25	TR	0
B-1-d	2/14/80	8.2	0.15	26	0.14	TR	0
B-2-s	2/14/80	7.2	2.1	78	0.12	TR	0
B-2-m	2/14/80	7.2	0.15	22	0.10	TR	0
B-2-d	2/14/80	7.2	0.16	26	0.10	TR	0
B-3-s	2/14/80	3.0	0.71	33	0.14	ND	0
B-3-m	2/14/80	3.0	0.14	25	0.12	TR	18
B-3-d	2/14/80	3.0	0.13	16	0.10	TR	85
C-1-s	2/21/80	NR	6.3	46	0.34	TR	0
C-2-s	DRY WELL						
C-2-d	2/14/80	11.6	0.17	8	0.15	TR	320
C-3-s	2/21/80	5.8	0.15	44	0.32	TR	0
C-3-m	2/21/80	5.8	0.19	44	0.29	TR	0
C-3-d	2/21/80	5.8	0.10	15	0.16	TR	0
C-4-s	2/19/80	4.1	6.0	21	0.11	0.021	0
C-4-m	2/19/80	4.1	0.19	26	0.10	TR	0
C-4-d	2/19/80	4.1	0.13	16	0.22	TR	0
C-5-s	2/21/80	3.5	5.2	22	0.18	ND	0
C-5-m	2/21/80	3.5	4.4	18	0.19	ND	0
C-5-d	2/21/80	3.5	0.22	14	0.10	TR	0
D-1-s	2/19/80	6.1	0.12	16	0.12	TR	0
D-1-m	2/19/80	6.1	0.09	9	0.21	TR	0
D-1-d	2/19/80	6.1	0.09	8	0.18	TR	5
D-2-s	2/20/80	2.4	0.24	33	0.17	TR	0
D-2-m	2/20/80	2.4	0.11	14	0.13	TR	0
D-2-d	2/20/80	2.4	0.28	21	0.14	TR	0
E-1-s	2/19/80	6.1	11.7	32	0.28	TR	0
E-1-m	2/19/80	6.1	0.10	12	0.23	TR	0
E-1-d	2/19/80	6.1	0.18	38	0.15	ND	0

Note: NR = Not Recorded
ND = None Detected
TR = Trace

TABLE 13. RESULTS FROM THE SEVENTH SAMPLING, PHASE 2

Well I.D.	Date	Depth to Water Table (m)	Nitrate-N (mg/1)	Chloride (mg/1)	Fluoride (mg/1)	MBAS (mg/1)	Fecal Coliform (Number/100 ml)
A-1-s	3/26/80	6.9	3.9	27	0.23	TR	0
A-1-m	3/26/80	6.9	0.47	24	0.11	TR	0
A-1-d	3/26/80	6.9	1.5	29	0.11	TR	0
A-2-s	3/24/80	8.8	5.7	41	0.14	TR	0
A-2-m	3/24/80	8.8	0.16	40	0.10	TR	0
A-2-d	3/24/80	8.8	0.18	31	0.10	TR	0
B-1-s	-------	-------	D R Y	W E L L	-------	-------	-------
B-1-m	3/24/80	9.8	1.3	1.2	0.07	TR	0
B-1-d	3/24/80	9.8	0.17	27	0.10	TR	0
B-2-s	3/26/80	6.7	11.2	102	0.09	TR	0
B-2-m	3/26/80	6.7	0.44	20	0.05	TR	0
B-2-d	3/26/80	6.7	0.52	25	0.08	TR	0
B-3-s	3/24/80	2.6	0.40	26	0.08	TR	0
B-3-m	3/24/80	2.6	0.22	23	0.12	TR	0
B-3-d	3/24/80	2.6	0.23	15	0.08	TR	0
C-1-s	3/27/80	NR	0.63	204	0.33	TR	0
C-2-s	-------	-------	D R Y	W E L L	-------	-------	-------
C-2-d	3/27/80	11.4	0.89	5.0	0.05	ND	0
C-3-s	3/26/80	6.1	6.6	44	0.29	TR	0
C-3-m	3/26/80	6.1	2.1	47	0.22	TR	0
C-3-d	3/26/80	6.1	0.53	11	0.11	TR	0
C-4-s	3/24/80	3.8	2.1	17	0.08	TR	0
C-4-m	3/24/80	3.8	0.88	22	0.09	TR	0
C-4-d	3/24/80	3.8	0.25	12	0.17	TR	0
C-5-s	3/25/80	3.7	4.7	19	0.13	TR	0
C-5-m	3/25/80	3.7	0.35	13	0.14	ND	0
C-5-d	3/25/80	3.7	0.28	9.4	0.17	TR	0
D-1-s	3/27/80	5.9	0.91	10	0.08	TR	0
D-1-m	3/27/80	5.9	0.30	6.4	0.17	TR	0
D-1-d	3/27/80	5.9	0.29	6.4	0.16	TR	0
D-2-s	3/25/80	2.1	0.34	30	0.12	TR	0
D-2-m	3/25/80	2.1	0.70	17	0.14	TR	0
D-2-d	3/25/80	2.1	0.44	11	0.06	ND	0
E-1-s	3/25/80	6.1	0.20	13	0.15	TR	0
E-1-m	3/25/80	6.1	0.30	9.2	0.23	TR	0
E-1-d	3/25/80	6.1	0.37	34	0.13	TR	0

Note: NR = Not Recorded
ND = None Detected
TR = Trace

TABLE 14. RESULTS FROM THE EIGHTH SAMPLING, PHASE 2

Well I.D.	Date	Depth to Water Table (m)	Nitrate-N (mg/1)	Chloride (mg/1)	Fluoride (mg/1)	MBAS (mg/1)	Fecal Coliform (Number/100 ml)
A-1-s	4/17/80	6.7	2.6	21	0.37	TR	0
A-1-m	4/17/80	6.7	0.11	22	0.25	TR	0
A-1-d	4/17/80	6.7	0.38	26	0.17	TR	0
A-2-s	4/15/80	8.8	9.0	37	0.26	0.021	0
A-2-m	4/15/80	8.8	0.27	37	0.18	TR	0
A-2-d	4/15/80	8.8	0.25	29	0.18	0.023	0
B-1-s			DRY	WELL			
B-1-m	4/14/80	6.7	1.1	5	0.17	TR	0
B-1-d	4/14/80	6.7	0.25	28	0.20	TR	0
B-2-s	4/17/80	6.7	0.11	18	0.16	TR	0
B-2-m	4/17/80	6.7	17.7	104	0.14	0.034	0
B-2-d	4/17/80	6.7	0.12	30	0.12	TR	0
B-3-s	4/14/80	2.6	0.83	41	0.09	TR	0
B-3-m	4/14/80	2.6	0.28	30	0.18	TR	0
B-3-d	4/14/80	2.6	0.28	17	0.15	TR	0
C-1-s	4/17/80	NR	0.36	302	0.54	TR	0
C-2-s			DRY	WELL			
C-2-d	4/16/80	11.6	0.14	8	0.17	TR	0
C-3-s	4/17/80	6.1	1.8	29	0.39	0.025	0
C-3-m	4/17/80	6.1	0.13	51	0.36	TR	0
C-3-d	4/17/80	6.1	0.12	16	0.18	TR	0
C-4-s	4/14/80	3.7	5.5	25	0.14	TR	0
C-4-m	4/14/80	3.7	0.42	33	0.40	TR	0
C-4-d	4/14/80	3.7	0.33	18	0.27	TR	0
C-5-s	4/16/80	3.7	3.3	26	0.24	TR	0
C-5-m	4/16/80	3.7	0.16	22	0.24	TR	0
C-5-d	4/16/80	3.7	0.13	14	0.21	TR	0
D-1-s	4/15/80	6.1	0.30	15	0.21	TR	0
D-1-m	4/15/80	6.1	0.30	11	0.28	TR	0
D-1-d	4/15/80	6.1	0.15	8	0.22	TR	0
D-2-s	4/16/80	2.7	0.17	43	0.19	0.021	0
D-2-m	4/16/80	2.7	0.21	18	0.13	TR	0
D-2-d	4/16/80	2.7	0.21	25	0.21	TR	0
E-1-s	4/16/80	6.1	0.08	19	0.23	TR	0
E-1-m	4/16/80	6.1	0.11	13	0.28	TR	0
E-1-d	4/16/80	6.1	0.17	52	0.17	0.054	0

Note: NR = Not Recorded
ND = None Detected
TR = Trace

TABLE 15. RESULTS FROM THE NINTH SAMPLING, PHASE 2

Well I.D.	Date	Depth to Water Table (m)	Nitrate-N (mg/1)	Chloride (mg/1)	Fluoride (mg/1)	MBAS (mg/1)	Fecal Coliform (Number/100 ml)
A-1-s	5/1/80	6.9	3.5	24	0.29	TR	0
A-1-m	5/1/80	6.9	0.08	23	0.11	0.099	0
A-1-d	5/1/80	6.9	0.97	27	0.10	0.039	0
A-2-s	4/28/80	8.8	4.6	36	0.20	0.036	0
A-2-m	4/28/80	8.8	0.07	37	0.12	TR	0
A-2-d	4/28/80	8.8	0.07	29	0.13	TR	0
B-1-s			DRY	WELL			
B-1-m	4/28/80	8.2	8.6	24	0.14	TR	0
B-1-d	4/28/80	8.2	0.05	29	0.09	TR	0
B-2-s	4/30/80	6.7	2.1	91	0.07	TR	5
B-2-m	4/30/80	6.7	0.05	24	0.08	TR	1
B-2-d	4/30/80	6.7	0.05	28	0.06	TR	0
B-3-s	4/28/80	2.4	0.39	35	0.11	TR	0
B-3-m	4/28/80	2.4	0.06	28	0.09	TR	0
B-3-d	4/28/80	2.4	0.05	19	0.07	TR	0
C-1-s	5/1/80	NR	0.32	41	0.44	TR	40
C-2-s			DRY	WELL			
C-2-d	4/29/80	11.6	0.05	2.7	0.08	0.039	0
C-3-s	4/30/80	6.1	0.07	20	0.52	TR	10
C-3-m	4/30/80	6.1	0.05	25	0.27	TR	0
C-3-d	4/30/80	6.1	0.05	9.3	0.10	TR	0
C-4-s	4/29/80	3.7	2.7	13	0.08	TR	0
C-4-m	4/29/80	3.7	0.18	15	0.07	TR	0
C-4-d	4/29/80	3.7	0.05	10	0.15	TR	0
C-5-s	5/1/80	2.7	4.8	12	0.14	0.065	0
C-5-m	5/1/80	2.7	0.09	9.3	0.18	0.047	0
C-5-d	5/1/80	2.7	0.06	9.1	0.19	0.025	0
D-1-s	4/29/80	6.1	0.05	12	0.43	TR	0
D-1-m	4/29/80	6.1	0.05	7.0	0.30	TR	0
D-1-d	4/29/80	6.1	0.05	5.5	0.15	TR	0
D-2-s	5/1/80	2.4	0.08	22	0.12	TR	2
D-2-m	5/1/80	2.4	0.05	11	0.08	TR	0
D-2-d	5/1/80	2.4	0.06	15	0.07	TR	3
E-1-s	4/30/80	6.1	0.05	12	0.16	TR	28
E-1-m	4/30/80	6.1	0.05	8.8	0.21	TR	4
E-1-d	4/30/80	6.1	0.05	29	0.10	0.020	5

Note: NR = Not Recorded
ND = None Detected
TR = Trace

TABLE 16. RESULTS FROM THE TENTH SAMPLING, PHASE 2

Well I.D.	Date	Depth to Water Table (m)	Nitrate-N (mg/1)	Chloride (mg/1)	Fluoride (mg/1)	MBAS (mg/1)	Fecal Coliform (Number/100 ml)
A-1-s	5/27/80	7.0	3.6	18	0.29	0.061	0
A-1-m	5/27/80	7.0	0.29	19	0.11	TR	0
A-1-d	5/27/80	7.0	0.86	21	0.14	0.048	0
A-2-s	6/2/80	9.1	1.1	25	0.22	0.039	16
A-2-m	6/2/80	9.1	0.20	24	0.16	0.024	0
A-2-d	6/2/80	9.1	0.20	21	0.16	0.036	2
B-1-s			DRY	WELL			
B-1-m	6/2/80	8.2	1.8	15	0.20	0.030	0
B-1-d	6/2/80	8.2	0.19	22	0.17	TR	8
B-2-s	6/3/80	6.9	0.20	51	0.22	0.051	10
B-2-m	6/3/80	6.9	0.07	19	0.14	0.021	2
B-2-d	6/3/80	6.9	0.06	21	0.13	TR	3
B-3-s	6/2/80	2.7	0.87	26	0.19	0.100	80
B-3-m	6/2/80	2.7	0.23	21	0.32	TR	1400
B-3-d	6/2/80	2.7	0.17	12	0.15	0.078	21
C-1-s			DRY	WELL			
C-2-s			DRY	WELL			
C-2-d	6/3/80	11.7	0.05	4.0	0.16	0.038	8
C-3-s	6/3/80	6.4	2.0	30	0.36	0.046	8
C-3-m	6/3/80	6.4	0.08	41	0.34	0.036	3
C-3-d	6/3/80	6.4	0.07	13	0.16	TR	10
C-4-s	5/29/80	4.0	2.4	15	0.08	0.036	0
C-4-m	5/29/80	4.0	0.28	15	0.41	0.044	0
C-4-d	5/29/80	4.0	0.25	13	0.15	0.072	0
C-5-s	5/27/80	3.8	4.4	15	0.14	0.065	0
C-5-m	5/27/80	3.8	0.27	13	0.18	0.027	0
C-5-d	5/27/80	3.8	0.25	10	0.13	0.028	0
D-1-s	5/29/80	6.1	0.28	11	0.21	TR	0
D-1-m	5/29/80	6.1	0.26	7.2	0.23	0.061	0
D-1-d	5/29/80	6.1	0.24	6.9	0.18	0.027	0
D-2-s	5/27/80	2.4	0.34	31	0.10	TR	0
D-2-m	5/27/80	2.4	0.25	11	0.14	0.040	0
D-2-d	5/27/80	2.4	0.27	18	0.04	0.030	0
E-1-s	5/29/80	6.1	0.24	21	0.18	0.084	0
E-1-m	5/29/80	6.1	0.22	10	0.15	TR	0
E-1-d	5/29/80	6.1	0.31	33	0.14	0.025	0

Note: NR = Not Recorded
ND = None Detected
TR = Trace

TABLE 17. RESULTS FROM THE ELEVENTH SAMPLING. PHASE 2

Well I.D.	Date	Depth to Water Table (m)	Nitrate-N (mg/1)	Chloride (mg/1)	Fluoride (mg/1)	MBAS (mg/1)	Fecal Coliform (Number/100 ml)
A-1-s	6/23/80	7.0	2.8	32	0.28	0.026	0
A-1-m	6/23/80	7.0	0.12	31	0.13	0.042	0
A-1-d	6/23/80	7.0	0.12	34	0.15	0.030	0
A-2-s	6/23/80	9.1	0.13	45	0.18	0.027	0
A-2-m	6/23/80	9.1	0.20	40	0.16	0.035	0
A-2-d	6/23/80	9.1	0.14	25	0.13	0.026	0
B-1-s			DRY	WELL			
B-1-m	6/24/80	8.4	7.6	23	0.18	0.038	0
B-1-d	6/24/80	8.4	0.11	27	0.13	0.022	0
B-2-s	6/26/80	6.7	2.8	75	0.13	0.030	0
B-2-m	6/26/80	6.7	0.05	23	0.10	0.041	0
B-2-d	6/26/80	6.7	0.08	27	0.07	0.024	0
B-3-s	6/26/80	2.7	1.7	34	0.17	0.025	0
B-3-m	6/26/80	2.7	0.08	25	0.22	0.036	0
B-3-d	6/26/80	2.7	0.05	17	0.11	0.024	0
C-1-s			WELL	LOST			
C-2-s			DRY	WELL			
C-2-d	6/26/80	11.7	0.05	7.0	0.11	0.030	0
C-3-s	6/24/80	6.1	4.1	40	0.30	0.022	0
C-3-m	6/24/80	6.1	0.15	50	0.26	0.026	0
C-3-d	6/24/80	6.1	0.11	18	0.14	TR	0
C-4-s	6/24/80	4.0	2.0	28	0.10	0.022	0
C-4-m	6/24/80	4.0	2.0	28	0.09	0.027	0
C-4-d	6/24/80	4.0	0.10	20	0.18	TR	0
C-5-s	6/25/80	3.7	5.2	22	0.16	TR	0
C-5-m	6/25/80	3.7	0.07	15	0.15	ND	0
C-5-d	6/25/80	3.7	0.05	12	0.16	TR	0
D-1-s	6/25/80	6.1	0.06	17	0.38	0.024	15
D-1-m	6/25/60	6.1	0.05	9	0.23	0.024	1
D-1-d	6/25/80	6.1	0.05	9	0.15	0.025	0
D-2-s	6/25/80	2.3	0.09	37	0.12	0.023	0
D-2-m	6/25/80	2.3	0.05	14	0.12	0.022	0
D-2-d	6/25/80	2.3	0.06	20	0.11	0.026	0
E-1-s	6/23/80	6.1	0.13	32	0.25	0.026	0
E-1-m	6/23/80	6.1	0.09	20	0.18	0.022	0
E-1-d	6/23/80	6.1	0.18	48	0.11	0.055	0

Note: NR = Not Recorded
ND = None Detected
TR = Trace

TABLE 18. RESULTS FROM THE TWELFTH SAMPLING, PHASE 2

Well I.D.	Date	Depth to Water Table (m)	Nitrate-N (mg/1)	Chloride (mg/1)	Fluoride (mg/1)	MBAS (mg/1)	Fecal Coliform (Number/100 ml)
A-1-s	7/30/80	7.0	3.7	22	0.41	0.046	25
A-1-m	7/30/80	7.0	0.34	20	0.14	0.025	0
A-1-d	7/30/80	7.0	0.50	22	0.13	0.031	1
A-2-s	7/28/80	9.1	0.85	31	0.20	0.028	0
A-2-m	7/28/80	9.1	0.34	29	0.11	0.029	0
A-2-d	7/28/80	9.1	0.37	25	0.12	0.021	0
B-1-s	DRY WELL						
B-1-m	7/28/80	8.2	1.6	22	0.18	0.066	40
B-1-d	7/28/80	8.2	0.33	25	0.15	0.022	0
B-2-s	7/30/80	6.7	2.1	60	0.17	0.034	0
B-2-m	7/30/80	6.7	0.31	23	0.10	0.036	0
B-2-d	7/30/80	6.7	0.28	24	0.10	TR	1
B-3-s	7/28/80	3.0	0.94	31	0.19	TR	2
B-3-m	7/28/80	3.0	0.31	20	0.14	TR	0
B-3-d	7/28/80	3.0	0.27	15	0.11	0.023	11
C-1-s	WELL LOST						
C-2-s	DRY WELL						
C-2-d	7/30/80	12.0	0.30	5.3	0.09	0.021	0
C-3-s	7/31/80	6.4	3.4	34	0.29	0.024	0
C-3-m	7/31/80	6.4	0.38	40	0.26	0.041	0
C-3-d	7/31/80	6.4	0.39	14	0.12	TR	0
C-4-s	7/29/80	4.3	1.7	22	0.09	0.047	0
C-4-m	7/29/80	4.3	0.35	23	0.22	0.031	1
C-4-d	7/29/80	4.3	0.32	15	0.25	0.021	0
C-5-s	7/31/80	3.8	3.8	26	0.23	0.030	0
C-5-m	7/31/80	3.8	0.36	15	0.28	0.030	0
C-5-d	7/31/80	3.8	0.41	12	0.17	0.027	0
D-1-s	7/29/80	6.1	0.38	16	0.30	0.036	150
D-1-m	7/29/80	6.1	0.29	9.5	0.27	0.030	9
D-1-d	7/29/80	6.1	0.24	7.5	0.19	0.043	0
D-2-s	7/31/80	2.6	0.35	32	0.18	0.025	0
D-2-m	7/31/80	2.6	0.31	12	0.15	0.041	0
D-2-d	7/31/80	2.6	0.36	20	0.14	0.034	0
E-1-s	7/29/80	6.4	0.35	21	0.26	0.060	0
E-1-m	7/29/80	6.4	0.26	12	0.23	0.021	6
E-1-d	7/29/80	6.4	0.39	38	0.18	0.034	0

Note: NR = Not Recorded
ND = None Detected
TR = Trace

out of 404 samples collected during the sampling program exceeded the federal standard. Incidence of such exceedence occurred four times at well E-1-s, three times at well B-2-s, twice at well B-1-m, and once each at wells A-2-s and B-2-m. The results of nitrate analyses for the twelve sampling events are presented graphically on Figure 21 through 32.

It can be seen from the results that measurable amounts of nitrate were observed throughout the study area and at all depths in the aquifer. At most of the well sites, the highest recorded nitrate levels were recorded at the shallow wells. In fact, exceedence of federal standards for finished drinking water occurred in only one case at a medium well (B-2-m on April 17, 1980). In the deep wells, values exceeded 1.0 mg/l only during the first sampling run.

Fluoride

Fluoride values were observed between 0.04 mg/l F and 1.2 mg/l F. This range may appear to be small, but the higher concentrations of fluoride involve significant implications. Fluoride may occur naturally in groundwater, with levels dependent on aquifer mineral constituents. The sediments constituting the Mill Creek aquifer may include fluoride-bearing materials which, while not native to the Louisville area, were carried by continental glaciers and deposited during the period of formation of the aquifer. A certain portion of fluoride observed in groundwater samples may thus be attributed to aquifer minerals.

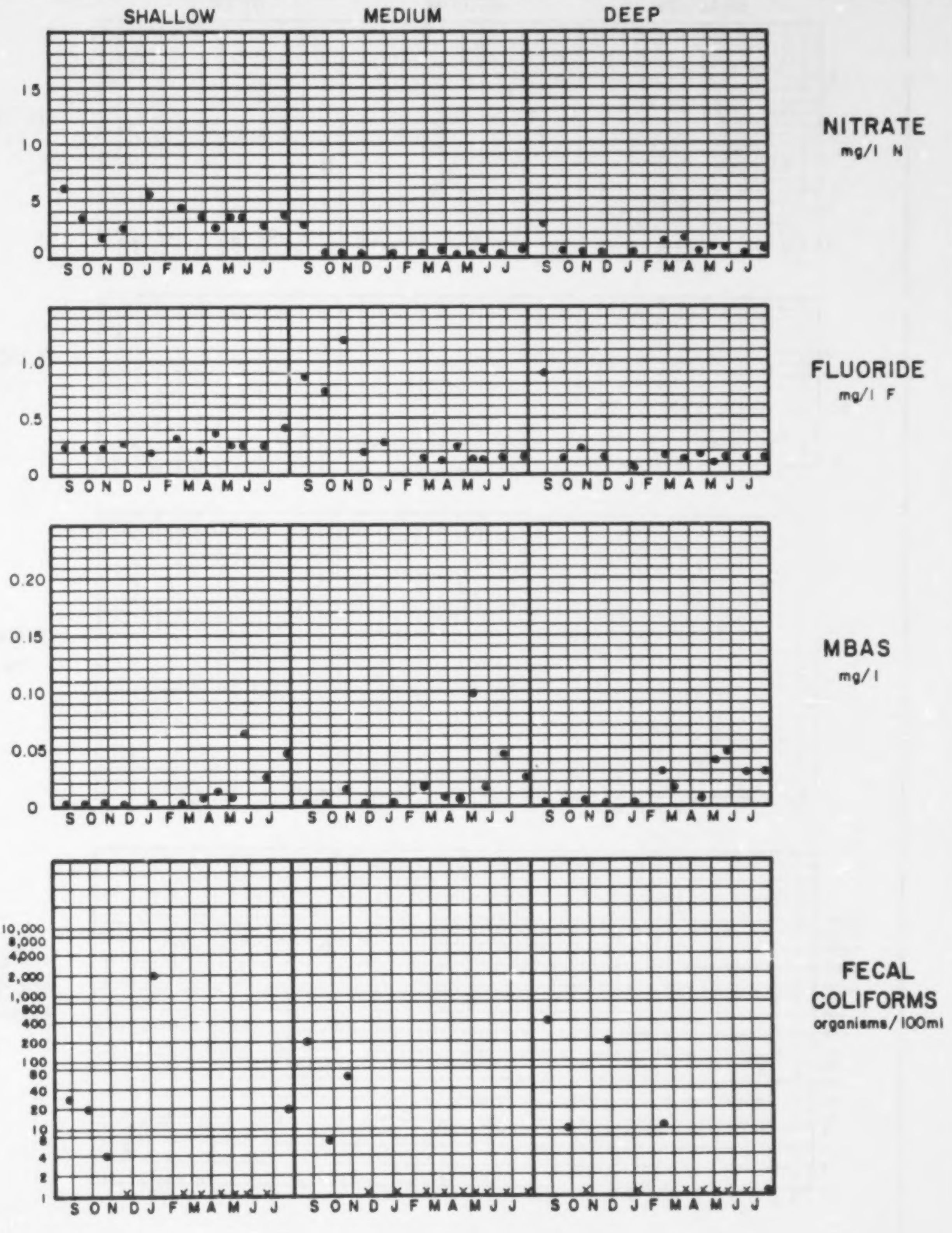
The highly variable nature of fluoride observations from one sampling event to the next at a single well suggests an additional source of fluoride in the system. Residential areas in the Mill Creek study area are served almost entirely by the Louisville Water Company (LWC). LWC water is fluoridated to the level of about 1 mg/l F. The source of high fluoride concentrations in many of the wells during the sampling program was probably LWC water.

Chloride

Chloride levels detected in the water samples range from 1.2 mg/l to 104 mg/l, except for well C-1 where levels ranged from 142 mg/l to 590 mg/l. In the case of well C-1, the decrease from the high recording of 590 mg/l was observed over time, suggesting the possibility of earlier, one-time contamination, perhaps from road salt storage near the well. In the case of other wells, most recordings were in the range of 20 mg/l to 40 mg/l.

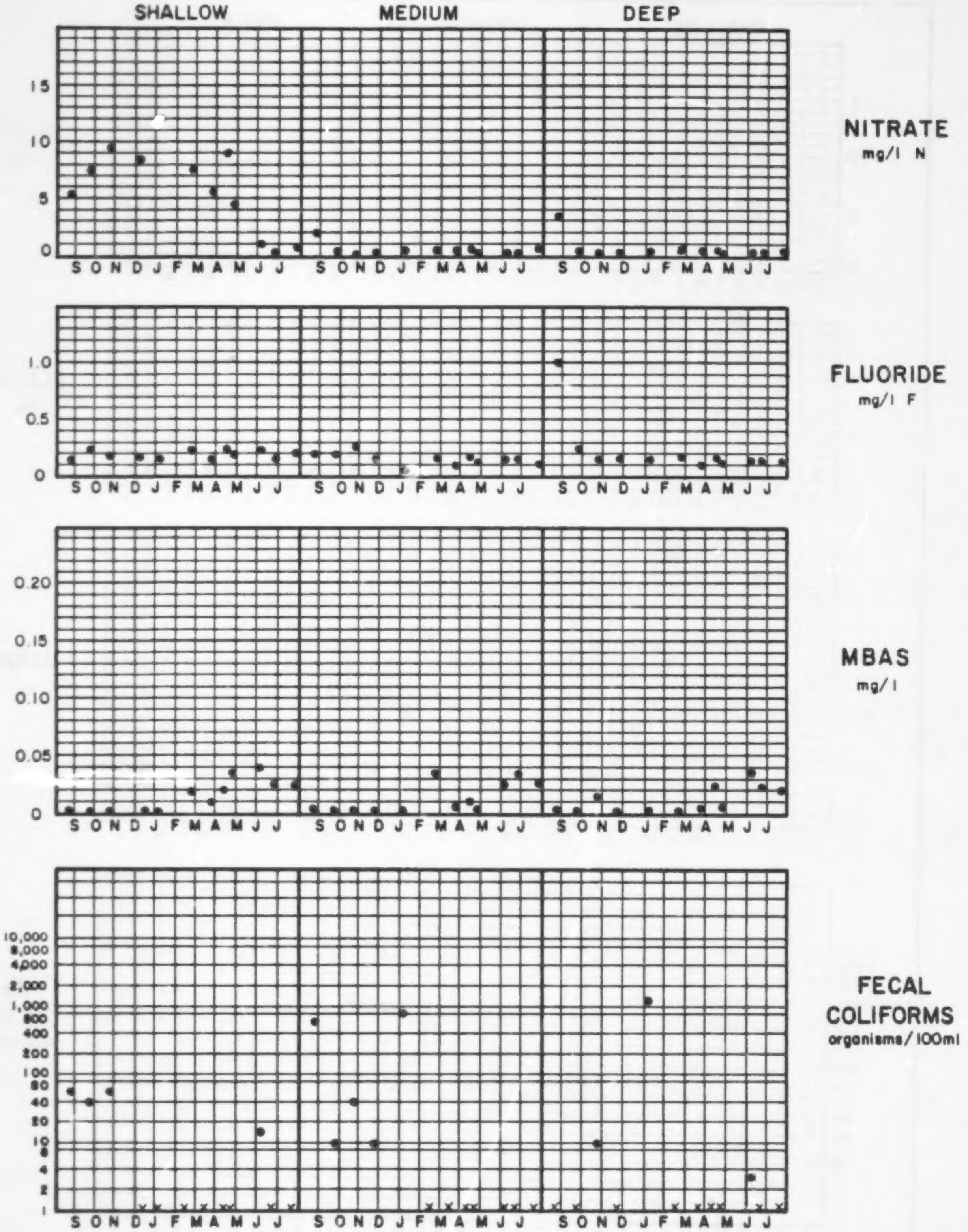
Methylene blue active substance (MBAS)

MBAS analyses are performed in order to detect the presence of synthetic laundry detergents in water. The analytical method for determination of MBAS is generally considered applicable over the range of 0.025 to 100.0 mg/l. Thus, significant levels of MBAS were recorded during sampling events 2, 3, 6, 8, 9, 10, 11, and 12. MBAS was observed to increase generally beginning in the eighth sampling run. By the twelfth run, 22 out of 36 wells showed significant levels of MBAS.



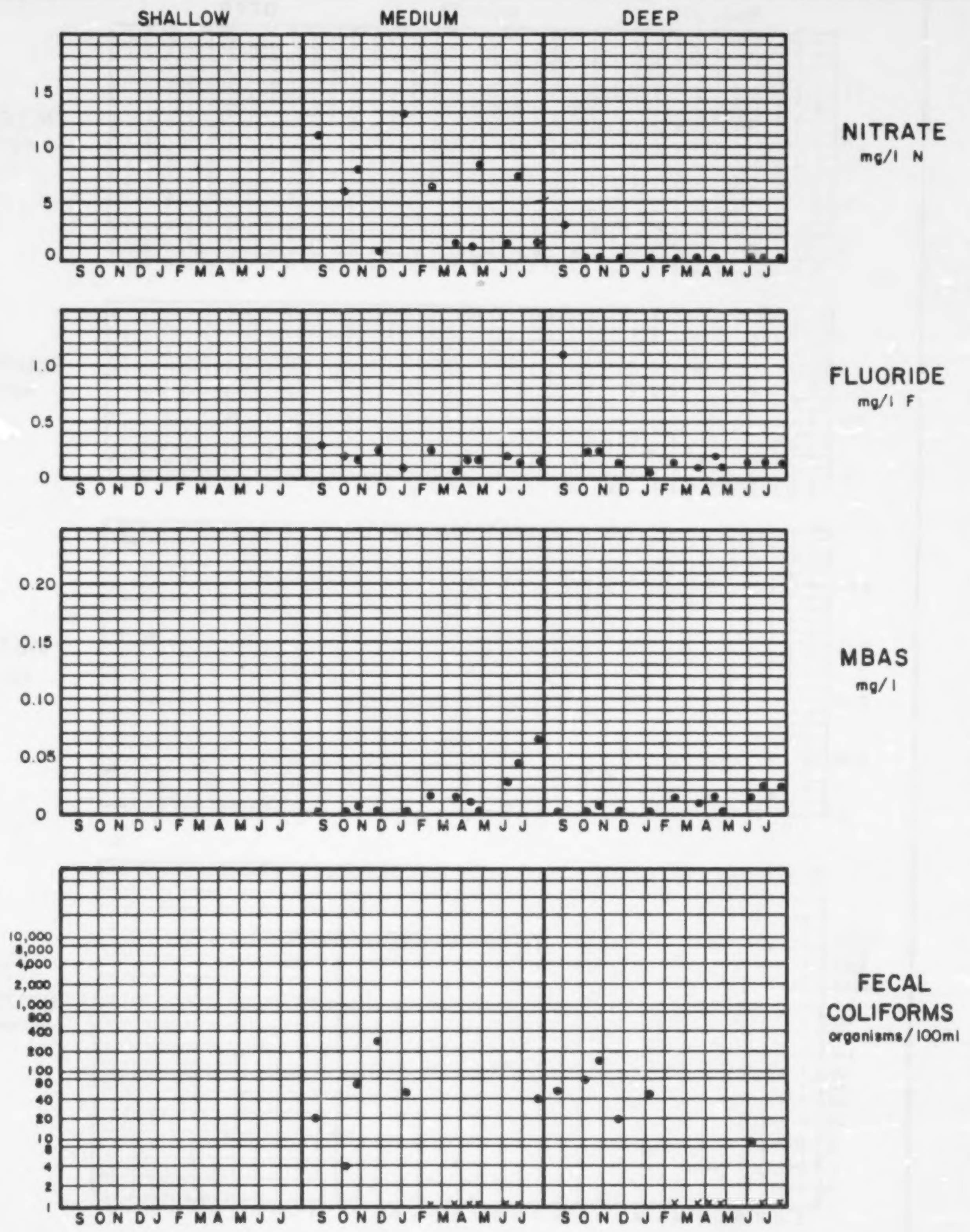
ANALYTICAL RESULTS
WELL SITE A-1

FIGURE 21



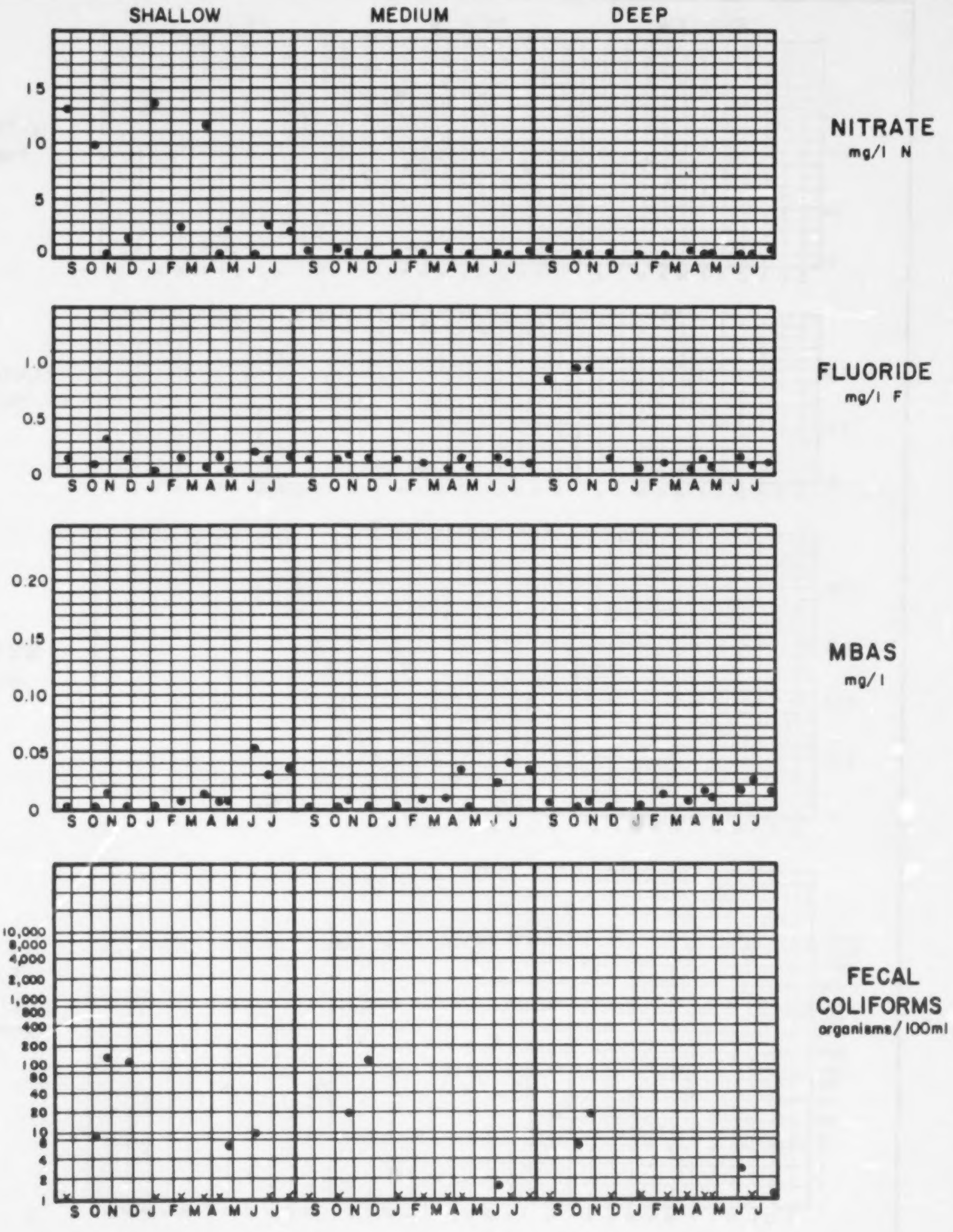
ANALYTICAL RESULTS
WELL SITE A-2

FIGURE



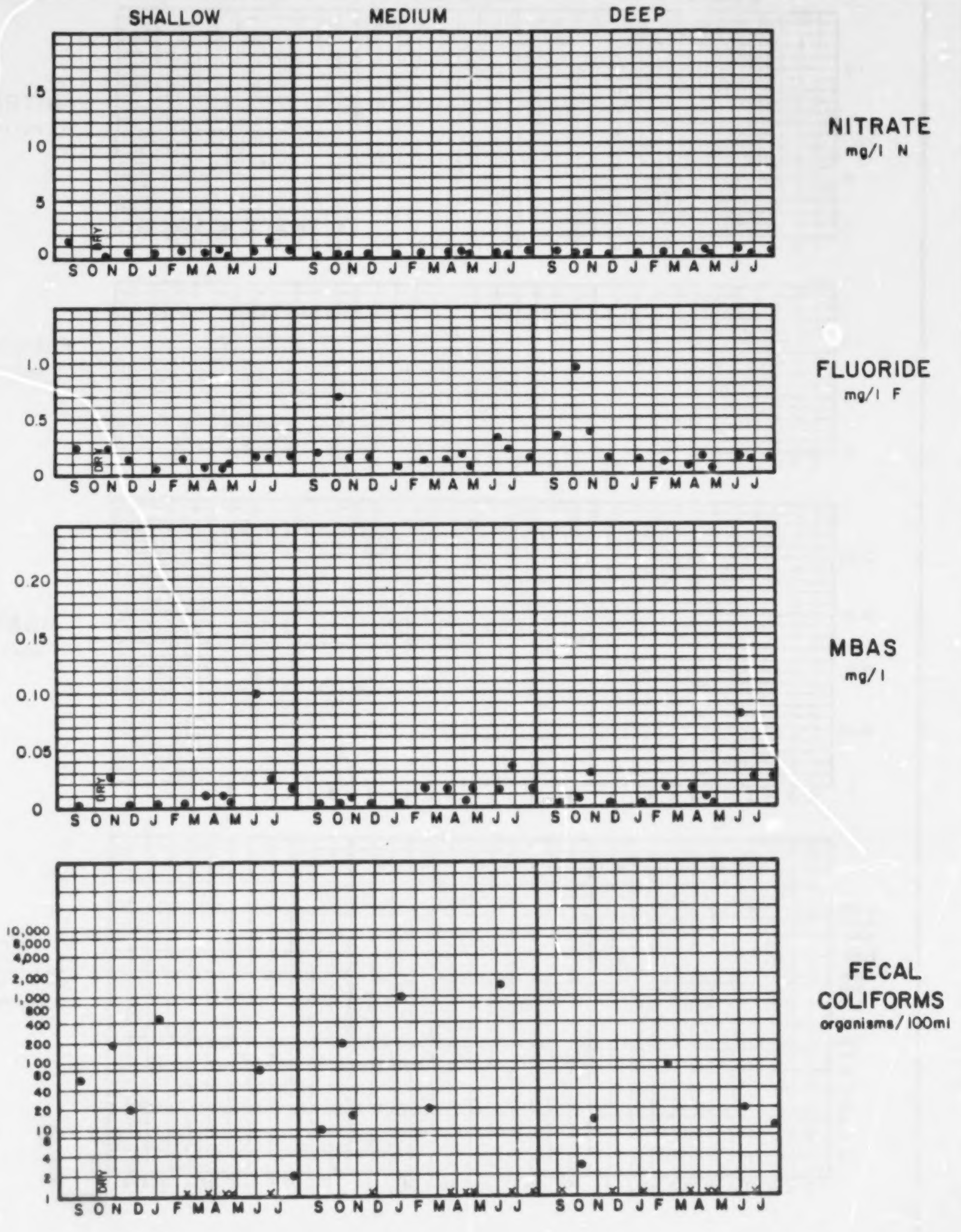
ANALYTICAL RESULTS
WELL SITE B-1

FIGURE 23



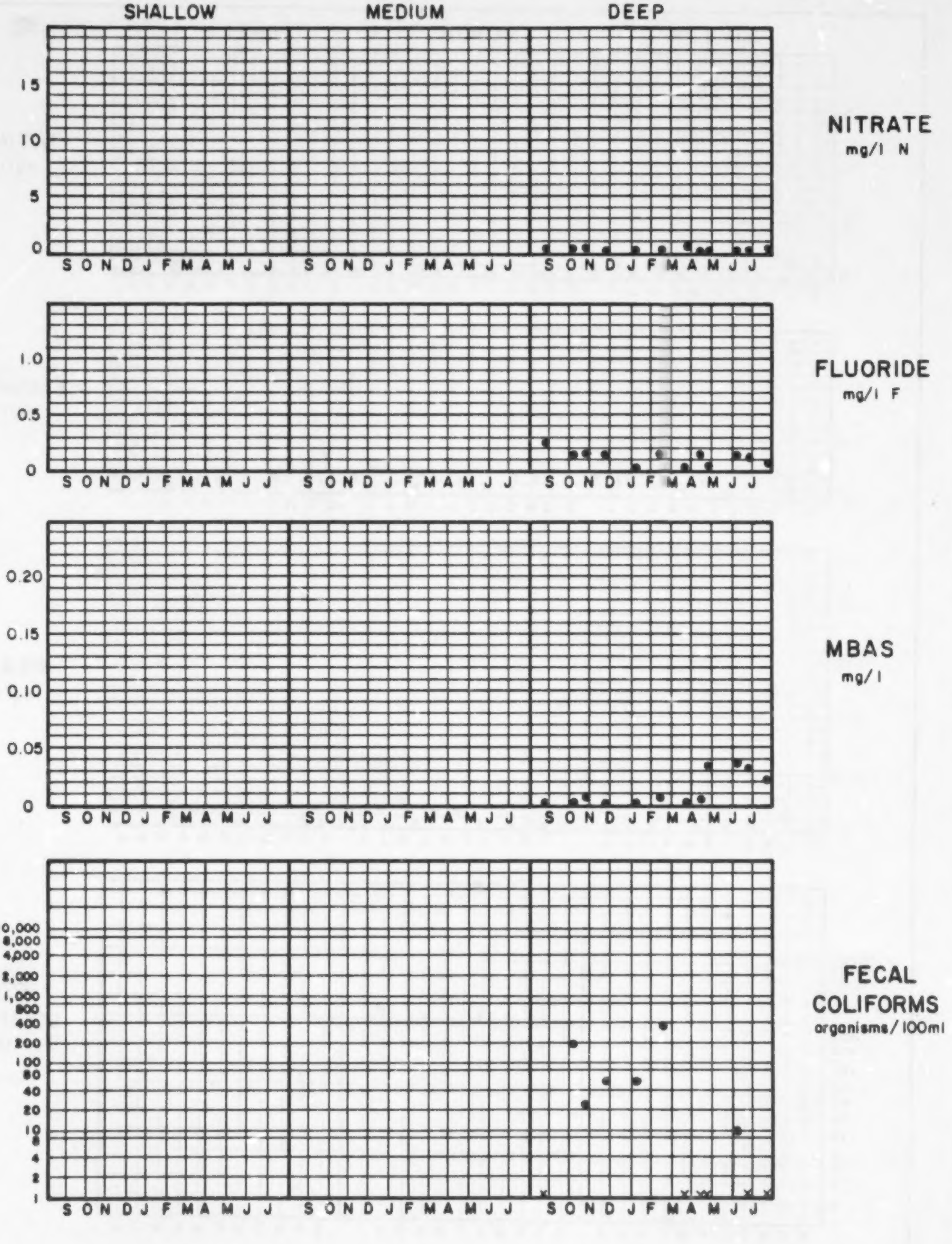
ANALYTICAL RESULTS
WELL SITE B-2

FIGURE



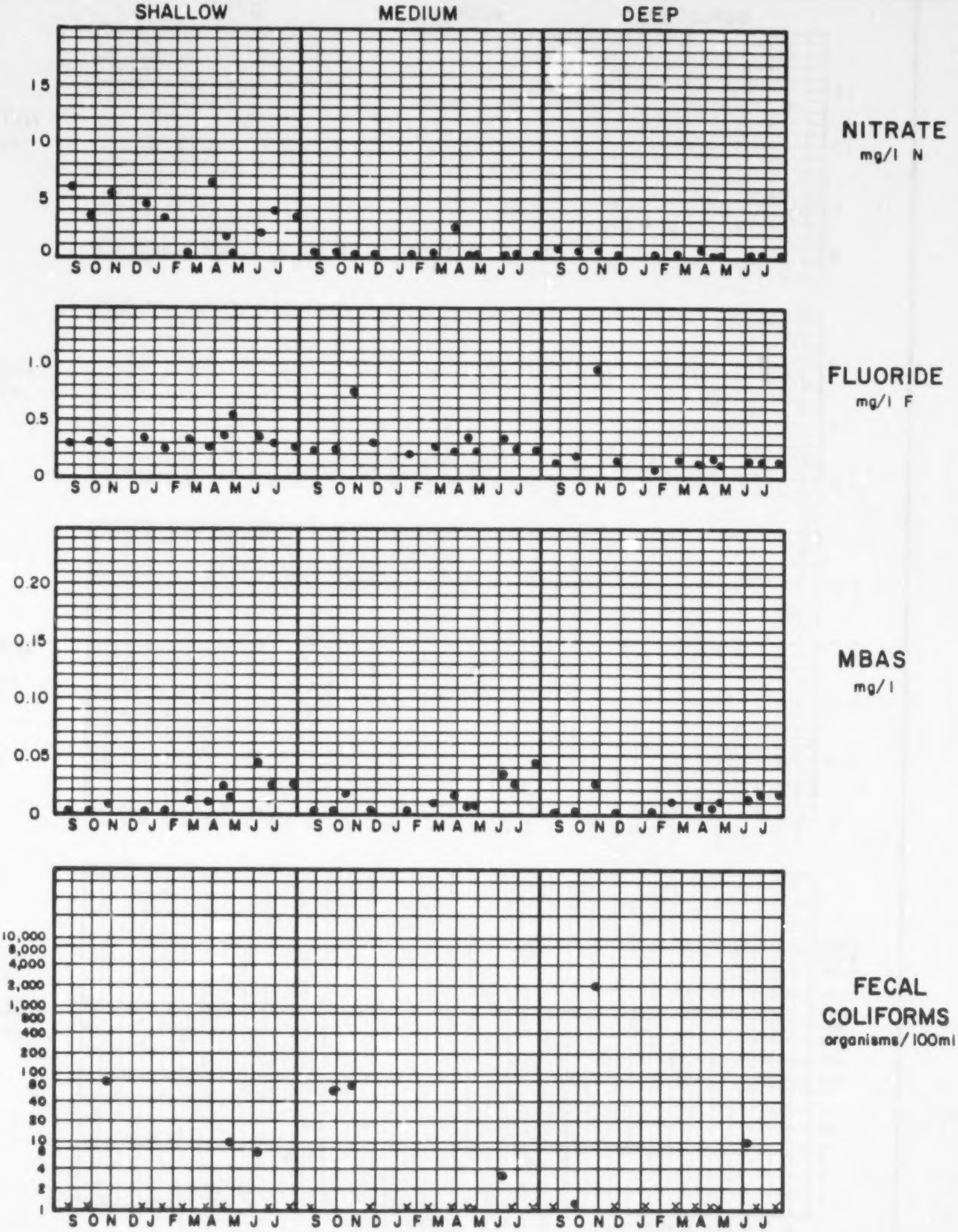
ANALYTICAL RESULTS
WELL SITE B-3

FIGURE 25



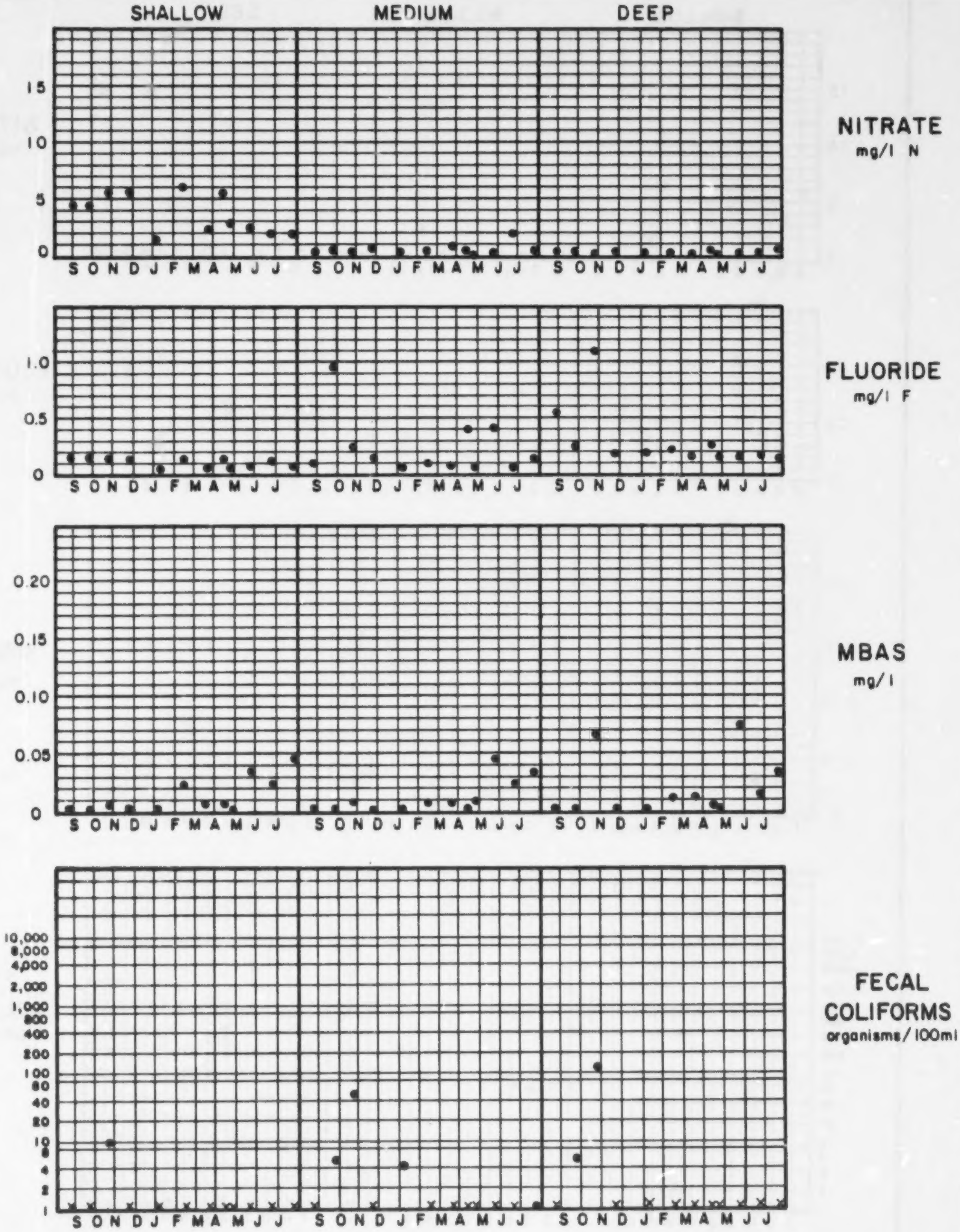
ANALYTICAL RESULTS
WELL SITE C-2

FIGURE



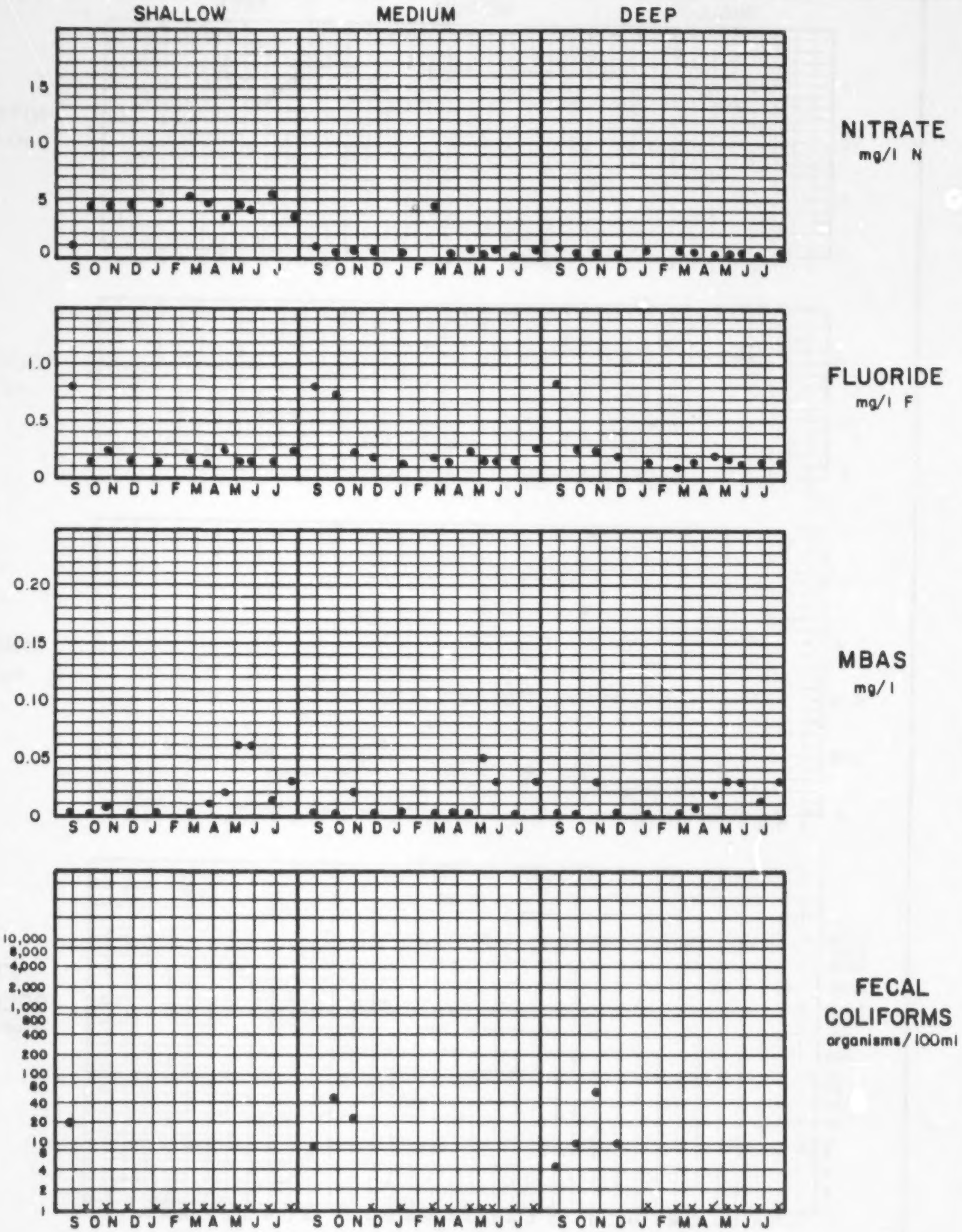
ANALYTICAL RESULTS
WELL SITE C-3

FIGURE 27



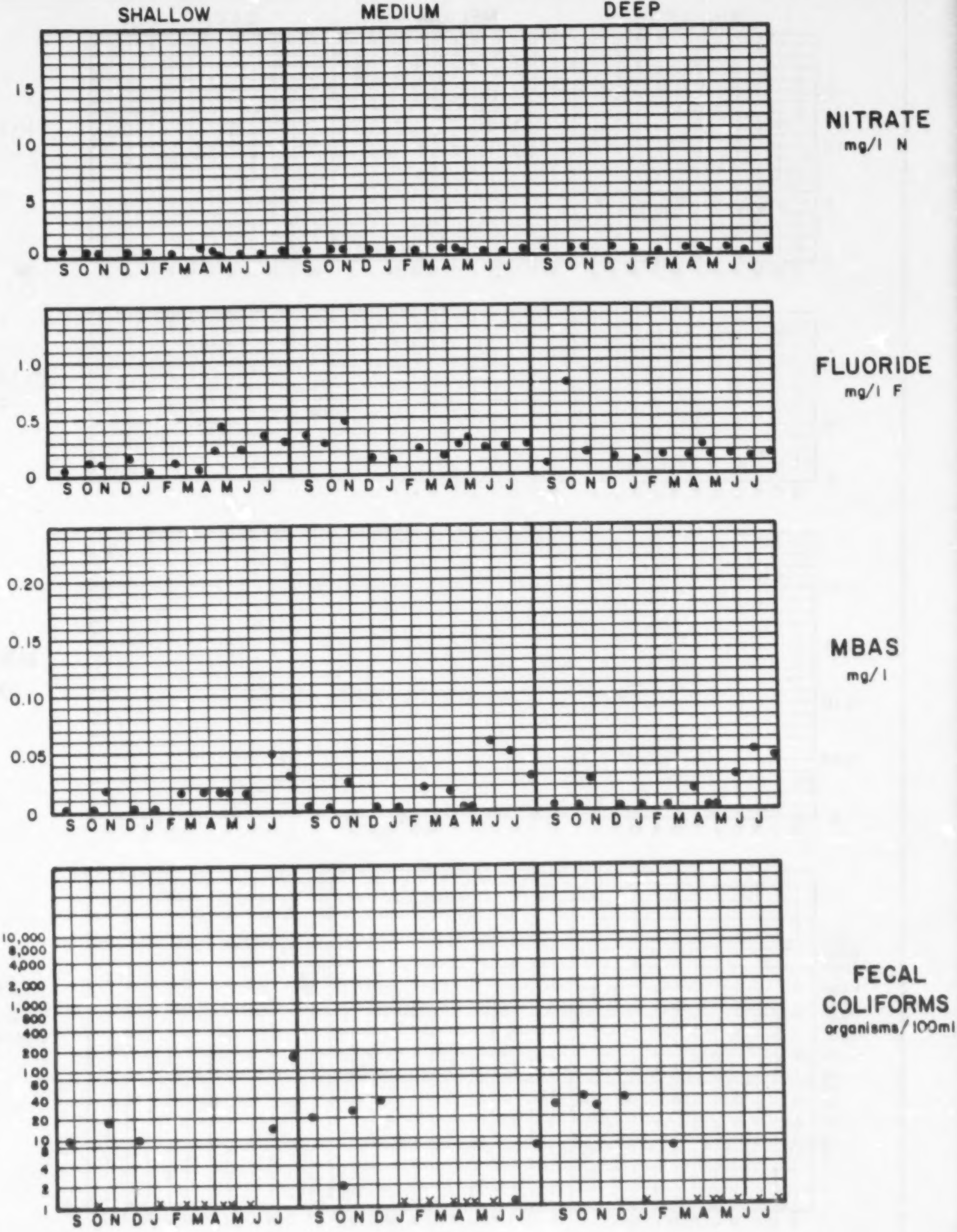
ANALYTICAL RESULTS
WELL SITE C-4

FIGURE



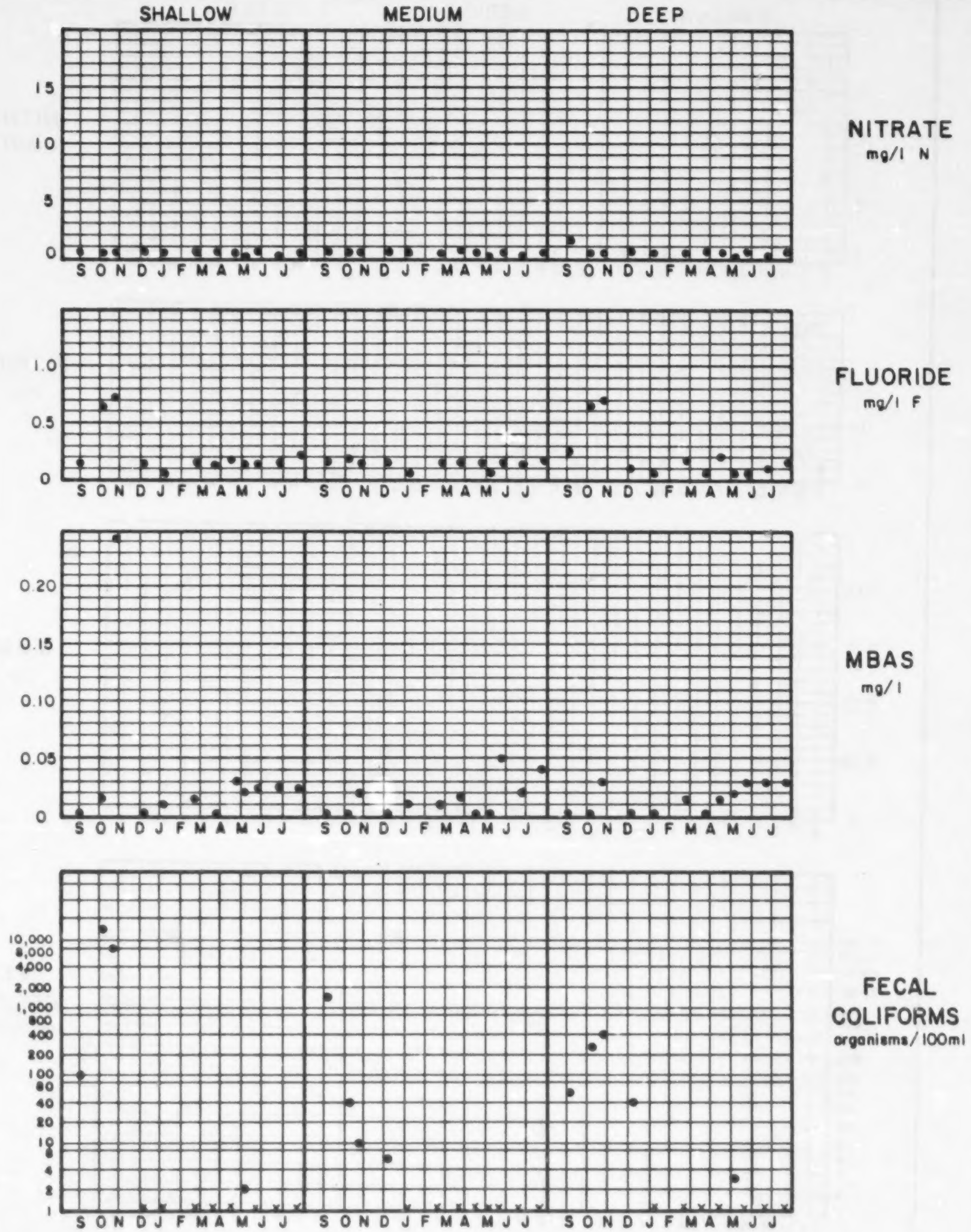
ANALYTICAL RESULTS
WELL SITE C-5

FIGURE 29



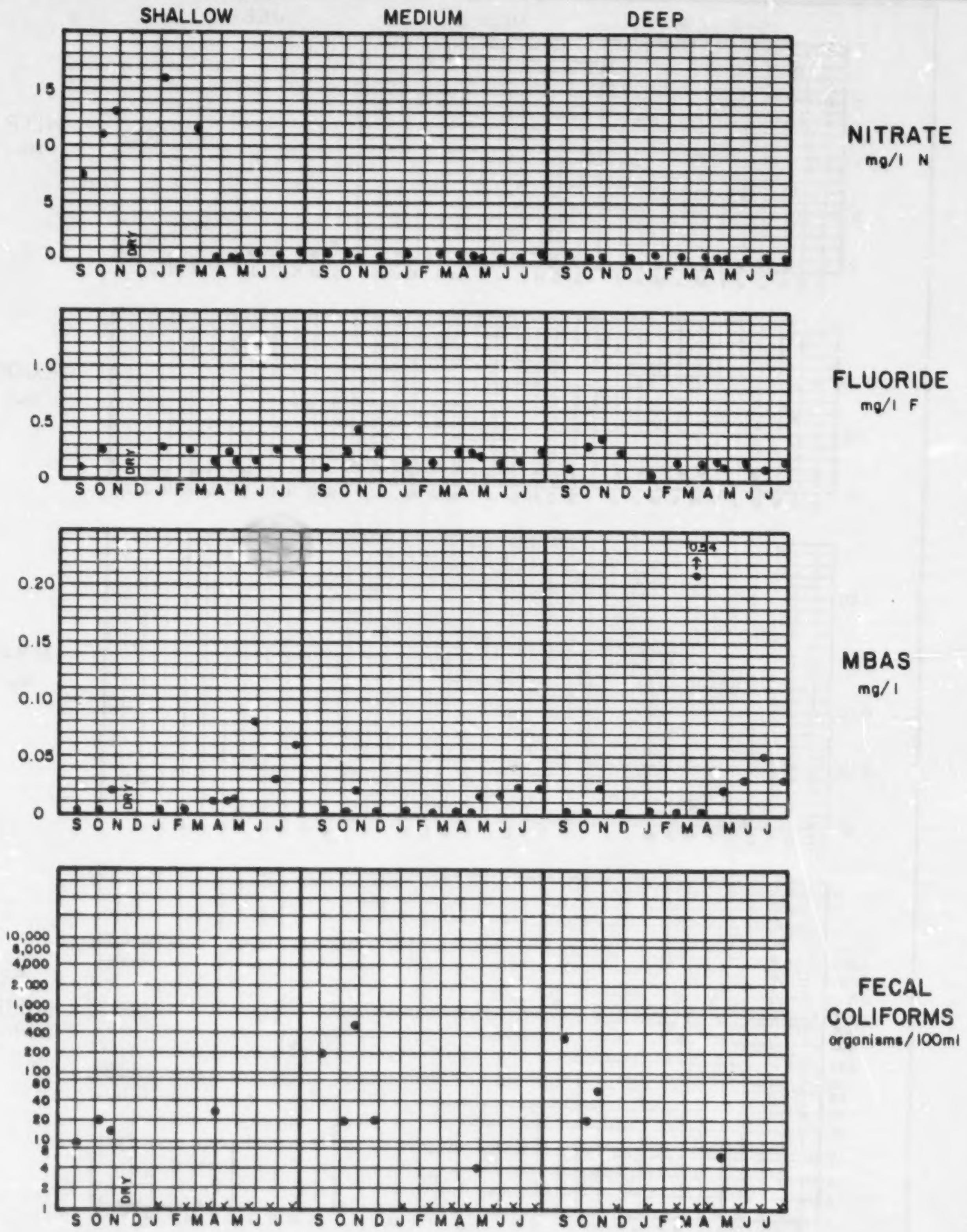
ANALYTICAL RESULTS
WELL SITE D-1

FIGURE



ANALYTICAL RESULTS
WELL SITE D-2

FIGURE 31



ANALYTICAL RESULTS
WELL SITE E-1

FIGURE

Fecal coliform bacteria

Coliform bacteria are commonly monitored in water supplies to provide inferential evidence of wastewater pollution. The federal standard for total coliform bacteria in finished drinking water is 4 organisms per 100 ml of water. Total coliform generally outnumber fecal coliforms in wastewater by a substantial factor. Thus, the isolation of even a single fecal coliform bacterium in a 100 ml water sample raises serious questions as to the purity of the water supply. Further, the presence of fecal coliforms infers the possibility of contamination by pathogenic bacteria and virus particles.

Every monitoring well has exhibited fecal coliform bacteria at least one time during the twelve sampling runs. The highest levels observed were during the third sampling run, in late October. At that time, fecal coliform bacteria were detected in all but one well. During twelve sampling runs, 142 of 404 samples had fecal coliforms present. Well site D-2 recorded the highest levels, with 18,000 fecal coliforms per 100 ml detected at the time of the second sampling event.

4.5.2 Interim Primary Drinking Water Standards Analyses

The results of IPDWS assays of selected wells in the study area are presented on Tables 19 through 25. For parameters other than nitrate, no exceedence of federal chemical standards for finished drinking water was observed. Of course, all positive fecal coliform observations constituted exceedence of bacteriological standards for finished drinking water.

4.5.3 Priority Pollutant Analyses

Laboratory reports of priority pollutant scans are presented in Appendix B. Methylene chloride was detected in two A-2-s samples: 61 ug/l on September 24, 1979 and 2100 ug/l on Febraury 20, 1980. The latter concentration is quite high, possibly indicating a problem of waste migration from the industrialized area to the north.

4.5.4 Aquifer Hydraulics

The Ohio River Alluvial aquifer in the Mill Creek study area is a relatively simple groundwater system. Granular aquifer material is bounded by nearly impermeable bedrock both at its eastern edge and at the bottom. Thus water is introduced into the aquifer only from above, and groundwater flows continuously and at a fairly rapid velocity toward the Ohio River. In order to understand the significance of results observed in the Phase 2 sampling program, one must first understand the response of the groundwater system to addition of water from above. The movement of recharge waters in the saturated zone will vary markedly, depending on precipitation. A conceptual model of the aquifer under dry weather and rain situations will be described to aid in identifying the causes of various responses.

TABLE 19. RESULTS FROM THE FIRST SAMPLING, PHASE 2: INTERIM PRIMARY DRINKING WATER STANDARDS ANALYSES

Well ID	A-2-s	B-2-s	C-3-s	D-2-s	E-1-S
Sampling Date	8/27/79	8/28/79	8/29/79	9/4/79	8/30/79
Arsenic	<0.002	<0.002	<0.002	<0.002	<0.002
Barium	<0.2	<0.2	<0.2	<0.2	<0.2
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	<0.02	<0.02	<0.02	<0.02	<0.02
Lead	<0.02	<0.02	<0.02	<0.02	<0.02
Mercury	<0.002	<0.002	<0.002	<0.002	<0.002
Nitrate (as N)	5.2	13	6.0	0.84	7.4
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	<0.01	<0.01	<0.01	<0.01	<0.01
Endrin	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
Lindane	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008
Methoxychlor	<0.01	<0.01	<0.01	<0.01	<0.01
Toxaphene	<0.001	<0.001	<0.001	<0.001	<0.001
2, 4-D	<0.02	<0.02	<0.02	<0.02	<0.02
2, 4, 5-TP Silvex	<0.002	<0.002	<0.002	<0.002	<0.002

Note: All concentrations are reported as mg/L.

TABLE 20. RESULTS FROM THE SECOND SAMPLING, PHASE 2:
INTERIM PRIMARY DRINKING WATER STANDARDS ANALYSES

Well ID	A-2-s	B-2-s	C-3-s	D-2-s	E-1-S
Sampling Date	9/24/79	10/1/79	9/26/79	10/3/79	10/3/79
Arsenic	<0.002	<0.002	<0.002	<0.002	<0.002
Barium	<0.05	<0.05	<0.05	0.06	<0.05
Cadmium	0.002	0.002	0.005	0.004	0.001
Chromium	<0.005	<0.005	<0.005	<0.005	<0.005
Lead	0.04	0.04	<0.01	0.03	0.02
Mercury	<0.002	<0.002	<0.002	<0.002	<0.002
Nitrate (as N)	7.3	9.8	3.5	0.27	11
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	<0.005	<0.005	<0.005	<0.005	<0.005
Endrin	<0.002	<0.002	<0.002	<0.002	<0.002
Lindane	<0.004	<0.004	<0.004	<0.004	<0.004
Methoxychlor	<0.1	<0.1	<0.1	<0.1	<0.1
Toxaphene	<0.005	<0.005	<0.005	<0.005	<0.005
2, 4-D	<0.1	<0.1	<0.1	<0.1	<0.1
2, 4, 5-TP Silvex	<0.01	<0.01	<0.01	<0.01	<0.01

Note: All concentrations are reported as mg/L.

TABLE 21. RESULTS FROM THE THIRD SAMPLING, PHASE 2: INTERIM PRIMARY DRINKING WATER STANDARDS ANALYSES

Well ID	A-2-s	B-2-s	C-3-s	D-2-s	E-1-S
Sampling Date	10/23/79	10/22/79	10/25/79	10/29/79	10/25/79
Arsenic	<0.002	<0.002	<0.002	<0.002	<0.002
Barium	<0.05	0.05	<0.05	0.05	<0.05
Cadmium	0.002	0.003	0.002	0.005	0.001
Chromium	<0.005	<0.005	<0.005	<0.005	<0.005
Lead	0.03	0.04	0.03	<0.01	<0.01
Mercury	<0.002	<0.002	<0.002	<0.002	<0.002
Nitrate (as N)	9.3	0.12	5.2	0.62	13
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	<0.005	<0.005	<0.005	<0.005	<0.005
Endrin	<0.002	<0.002	<0.002	<0.002	<0.002
Lindane	<0.004	<0.004	<0.004	<0.004	<0.004
Methoxychlor	<0.01	<0.01	<0.01	<0.01	<0.01
Toxaphene	<0.005	<0.005	<0.005	<0.005	<0.005
2, 4-D	<0.1	<0.1	<0.1	<0.1	<0.1
2, 4, 5-TP Silvex	<0.01	<0.01	<0.01	<0.01	<0.01

Note: All concentrations are reported as mg/L.

TABLE 22. RESULTS FROM THE FOURTH SAMPLING, PHASE 2: INTERIM PRIMARY DRINKING WATER STANDARDS ANALYSES

Well ID	A-2-s	B-2-s	C-3-s	D-2-s	E-1-S
Sampling Date	12/12/79	11/26/79	12/12/79	12/3/79	dry
Arsenic	<0.002	<0.002	<0.002	<0.002	
Barium	<0.05	<0.05	<0.05	0.08	
Cadmium	<0.002	<0.002	<0.002	<0.002	
Chromium	<0.01	<0.01	<0.01	<0.01	
Lead	<0.01	<0.01	<0.01	<0.01	
Mercury	<0.002	<0.002	<0.002	<0.002	
Nitrate (as N)	8.5	1.2	4.5	0.11	
Selenium	<0.01	<0.01	<0.01	<0.01	
Silver	<0.005	<0.005	<0.005	0.008	
Endrin	<0.00004	<0.00004	<0.00004	<0.00004	
Lindane	<0.0008	<0.0008	<0.0008	<0.0008	
Methoxychlor	<0.01	<0.01	<0.01	<0.01	
Toxaphene	<0.001	<0.001	<0.001	<0.001	
2, 4-D	<0.02	<0.02	<0.02	<0.02	
2, 4, 5-TP Silvex	<0.002	<0.002	<0.002	<0.002	

Note: All concentrations are reported as mg/L.

TABLE 23. RESULTS FROM THE FIFTH SAMPLING, PHASE 2: INTERIM PRIMARY DRINKING WATER STANDARDS ANALYSES

Well ID	A-2-s	B-2-s	C-3-s	D-2-s	E-1-S
Sampling Date	1/2/80	1/3/80	1/7/80	1/9/80	1/9/80
Arsenic	<0.002	<0.002	<0.002	<0.002	<0.002
Barium	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01
Lead	<0.01	<0.01	<0.01	<0.01	<0.01
Mercury	<0.002	<0.002	<0.002	<0.002	<0.002
Nitrate (as N)	12.0	13.7	3.1	0.21	16.0
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	<0.005	<0.005	<0.005	<0.005	<0.005
Endrin	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
Lindane	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008
Methoxychlor	<0.01	<0.01	<0.01	<0.01	<0.01
Toxaphene	<0.001	<0.001	<0.001	<0.001	<0.001
2, 4-D	<0.02	<0.02	<0.02	<0.02	<0.02
2, 4, 5-TP Silvex	<0.002	<0.002	<0.002	<0.002	<0.002

Note: All concentrations are reported as mg/L.

TABLE 24. RESULTS FROM THE SIXTH SAMPLING, PHASE 2: INTERIM PRIMARY DRINKING WATER STANDARDS ANALYSES

Well ID	A-2-s	B-2-s	C-3-s	D-2-s	E-1-S
Sampling Date	2/20/80	2/14/80	2/21/80	2/20/80	2/19/80
Arsenic	<0.005	<0.005	<0.005	<0.005	<0.005
Barium	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01
Lead	<0.01	<0.01	<0.01	<0.01	<0.01
Mercury	<0.002	<0.002	<0.002	<0.002	<0.002
Nitrate (as N)	7.8	2.1	0.15	0.24	11.7
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	<0.005	<0.005	<0.005	<0.005	<0.005
Endrin	<0.00004	<0 00004	<0.00004	<0.00004	<0.00004
Lindane	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008
Methoxychlor	<0.01	<0.01	<0.01	<0.01	<0.01
Toxaphene	<0.001	<0.001	<0.001	<0.001	<0.001
2, 4-D	<0.02	<0.02	<0.02	<0.02	<0.02
2, 4, 5-TP Silvex	<0.002	<0.002	<0.002	<0.002	<0.002

Note: All concentrations are reported as mg/L.

TABLE 25. RESULTS FROM THE SEVENTH SAMPLING, PHASE 2: INTERIM PRIMARY DRINKING WATER STANDARDS ANALYSES

Well ID	A-2-d	B-2-d	C-2-d	D-2-d	E-1-d
Sampling Date	3/24/80	3/26/80	3/26/80	3/25/80	3/25/80
Arsenic	<0.005	<0.005	<0.005	<0.005	<0.005
Barium 0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01
Lead	<0.01	<0.01	<0.01	<0.01	<0.01
Mercury	<0.002	<0.002	<0.002	<0.002	<0.002
Nitrate (as N)	0.18	0.52	0.89	0.44	0.37
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	<0.005	<0.005	<0.005	<0.005	<0.005
Endrin	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
Lindane	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008
Methoxychlor	<0.01	<0.01	<0.01	<0.01	<0.01
Toxaphene	<0.001	<0.001	<0.001	<0.001	<0.001
2, 4-D	<0.02	<0.02	<0.02	<0.02	<0.02
2, 4, 5-TP Silvex	<0.002	<0.002	<0.002	<0.002	<0.002

Note: All concentrations are reported as mg/L.

During dry conditions, recharge waters flow from seepage pits in developed areas where on-site wastewater disposal systems are used. Effluent from seepage pits travels toward the groundwater table and enters the saturated zone with a particular vertical velocity. The magnitude of this downward velocity will depend upon the rate of infiltration. Conceptually, the recharged water will move as shown in Figure 33; the geometry of the aquifer will force the water to move more horizontally as it moves toward the impermeable base. A larger rate of infiltration will result in a higher downward velocity.

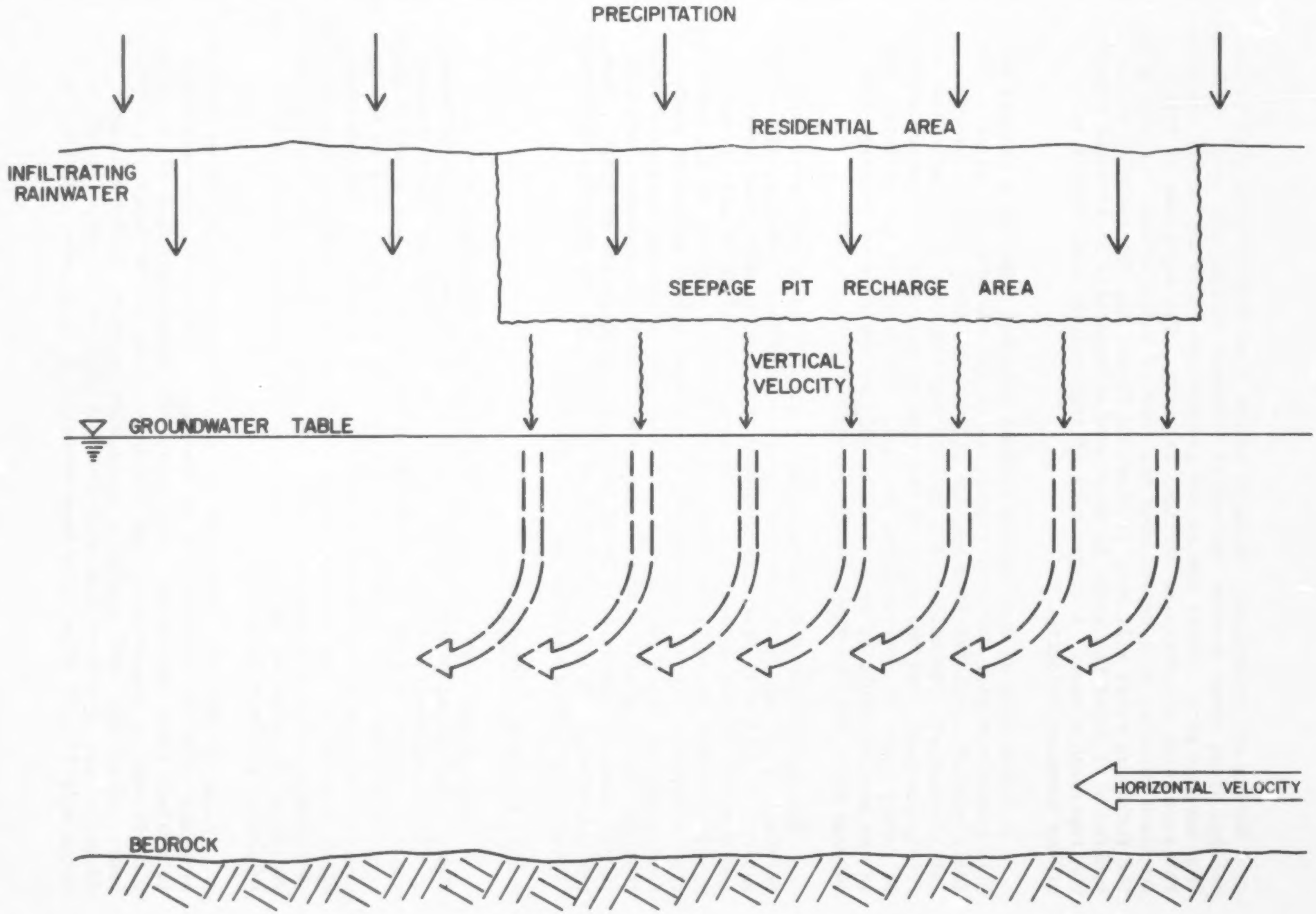
A higher rate of application (volume per unit time) to a seepage pit will generate higher vertical velocities in the vicinity of the pit. The daily rate of discharge from seepage pits in the study area is probably fairly constant. Therefore, the rate of infiltration is probably also fairly constant, and the depth of the zone of polluted groundwater would be fairly constant over a period of time. The depth of the polluted zone in the aquifer would be related ultimately to the rate of recharge from seepage pits, but the position would remain fairly constant.

The path followed by recharge water will be quite different under rainfall conditions when compared to dry conditions. Precipitation which enters the soil will percolate downward and provide additional vertical infiltration to the water table. The larger infiltration will impose a higher downward velocity on recharge waters. The position in the saturated zone to which polluted recharge water is driven may be different under dry conditions and after rain events. In addition to causing increased infiltration, rainfall will probably raise the water table somewhat, and will likely cause an increase in local horizontal groundwater velocity. Thus, the relative positions of polluted water under dry and rainfall conditions cannot be determined without aquifer modeling.

4.5.5 Fluoride Observations

Fluoride was used as a tag on LWC water for the purposes of this study. The LWC also uses fluoride to infer the probable source of water in flooded basements in the water service area. Fluoride concentrations around 1 mg/1 F lead water company investigators to suspect a broken water main as the source of flooding, while low fluoride levels (0.1 to 0.2 mg/1 F) usually indicate groundwater infiltration. This range of fluoride observations occurred in the sampling wells during the five sampling periods. Many groundwater samples exhibited fluoride in the low range, while other samples contained fluoride at concentrations that indicated the presence of undiluted LWC water at the well screen.

Fluoride does not decay, yet its concentration in samples varied considerably from one sampling run to the next. Several factors would help to explain these variations. The hydrologic conditions that allow seepage pit effluent to penetrate to the deeper portions of the aquifer are transient. After they have reached a particular position in the aquifer, fluoride-bearing waters flow away from the zone of the sampling wells. Since only 13 well sites have been established in an area comprised of


PRECIPITATION
RESIDENTIAL AREA
INFILTRATING RAINWATER
SEEPAGE PIT RECHARGE AREA
VERTICAL VELOCITY
GROUNDWATER TABLE
HORIZONTAL VELOCITY
BEDROCK

GENERAL AQUIFER HYDRAULICS

FIGURE

almost 80 km^2 (30 mi^2) and approximately 1 billion m^3 (40 billion ft^3) of saturated sediments, each sampling event represents only a pinpoint in time and space. In addition to moving away from a sampling well at the general groundwater horizontal velocity, fluoride-bearing water "slugs" would be subject to dispersion. As the water moves horizontally toward the river, it travels through the porous zones around aquifer sediments. As this path is followed, fluoride ions in the water become "spread out", or dispersed, as shown schematically in Figure 34. Dispersion would occur in three dimensions. Without the introduction of additional fluoride, it would disperse throughout the system and decrease to relatively low levels.

4.5.6 Nitrate Observations

The most obvious observation that can be made regarding nitrate levels in Phase 2 samples is that during the sampling runs, nitrate was most apparent in shallow wells. Medium and deep wells generally exhibited nitrate levels of several milligrams per liter in the first sampling (end of August) after which the constituent dropped to very low levels. The contrasting observations of nitrate and fluoride concentrations are perplexing. Generally, high fluoride levels, indicating the presence at the well screen of undiluted LWC water, were observed in deeper wells, while high nitrate values were observed in shallow wells. Definition of the geochemical or biochemical mechanism responsible for these seemingly contradictory observations must await further study.

4.5.7 Fluoride and Nitrate Comparisons

Comparison of fluoride and nitrate observations at the Phase 2 well sites presents several problems that must be resolved if one is to develop a complete understanding of pollutant impact on the aquifer. The most obvious questions are:

1. If high fluoride values represent LWC water, then why are high nitrate values not also observed?

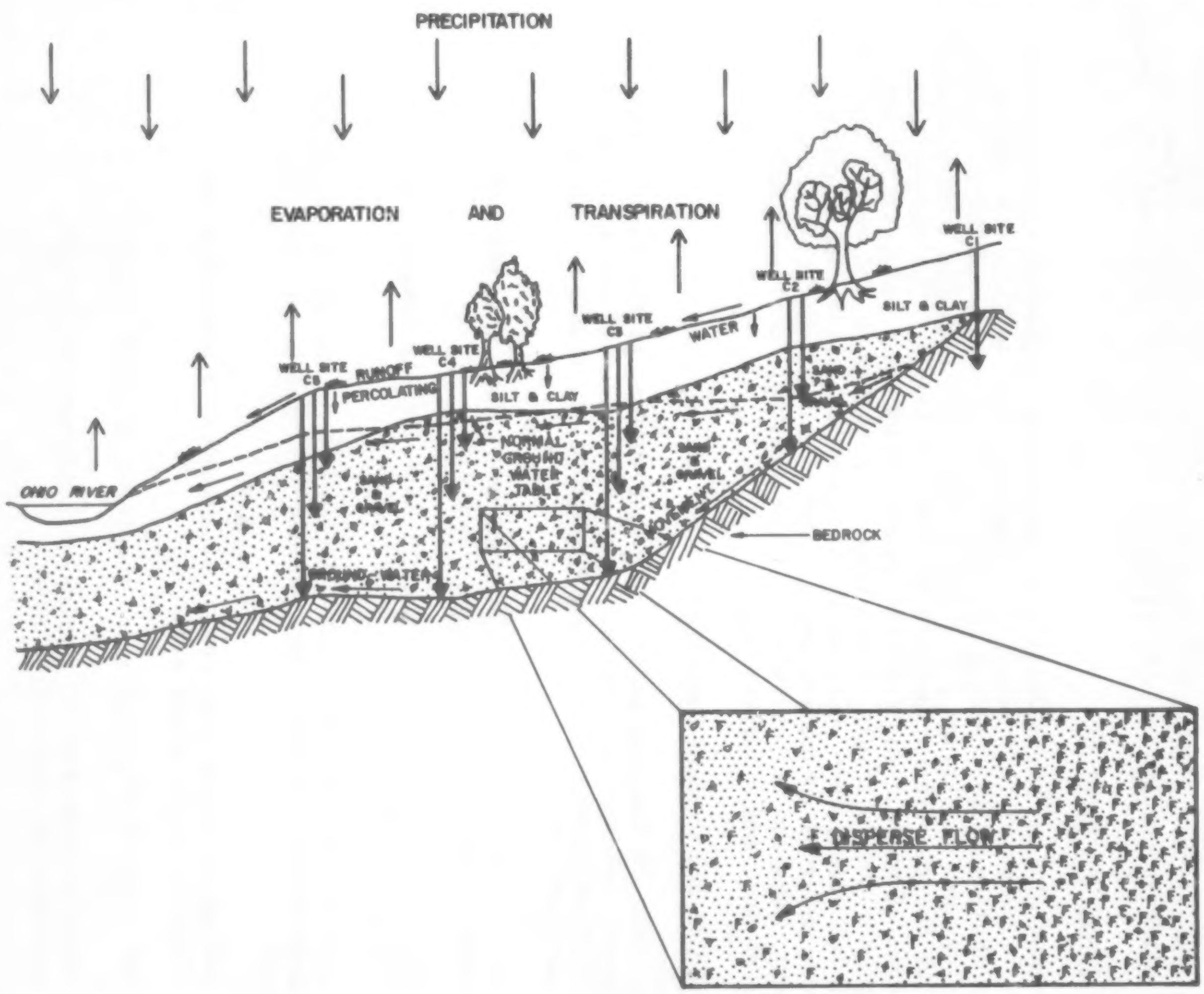
2. Why do the shallow wells exhibit high nitrate levels, but fairly low fluoride concentrations?

In order to explore the possible explanations for the fluoride and nitrate observations, certain basic premises, listed below, must be established:

1. LWC water is the only source of appreciable quantities of fluoride in the study area.

2. LWC water is fluoridated to the level of about 1 mg/1 F.

3. Fluoride undergoes no chemical transformations in the saturated or unsaturated zone.


PRECIPITATION
EVAPORATION AND TRANSPIRATION
WELL SITE C1
WELL SITE C2
WELL SITE C3
WELL SITE C4
WELL SITE C5
SILT & CLAY
WATER
RUNOFF
PERCOLATING
SILT & CLAY
OHIO RIVER
SAND & GRAVEL
NORMAL GROUND WATER TABLE
SAND & GRAVEL
SAND & GRAVEL
GROUND WATER
BEDROCK
DISPERSE FLOW

DISPERSION OF FLUORIDE
IN AQUIFER

FIGURE

In contrast to fluoride, nitrate may be derived from several sources in the study area, and it may be transformed by microorganisms in the soil, under certain environmental conditions. Sources of nitrate in the study area may include:

1. Seepage pit effluent
2. Agricultural practices or domestic fertilizer
3. Water in surface drainageways

Nitrate may be acted upon by a certain group of microorganisms, the facultative anaerobic bacteria, according to the following general biochemical reaction:

$$\text{nitrate} + \begin{array}{l}\text{organic}\\ \text{material}\end{array} \xrightarrow[\text{anaerobic bacteria}]{\text{facultative}} \text{nitrogen gas}$$

This reaction, the denitrification reaction, produces a nitrogen product which is not detected in the chemical analysis for nitrate. Bacteria capable of carrying out the denitrification reaction are widespread in domestic wastewater and in certain soil environments. The single most critical determinant of microorganism density in soil is the presence and abundance of a usable food source, usually organic materials. Generally, very few microorganisms are detected in soils below a depth of 0.3-0.6m (1-2 ft). Food is simply not available, and deeper soils are essentially devoid of bacteria. The introduction of domestic wastewater and associated bacteria deep beneath the ground surface, as it occurs in the Mill Creek area, may produce a deeper zone of bacterial activity. Support for this hypothesis cannot be derived from Phase 2 results. Further study of nitrate profiles would be necessary if the hypothesis is to be tested.

Although the problem presented by comparison of fluoride and nitrate values must await further study for resolution, the probable source of nitrate observed in the shallow wells can be suggested. It is certainly possible that nitrate detected during certain periods of the year is derived from fertilizer usage at the ground surface. However, the very high nitrate levels observed in samples from wells A-2-s, B-1-m, B-2-s, and E-1-s early in January probably did not result from fertilizer use, since little, if any, fertilization would have been carried out beyond October or November. The close proximity of most well sites to surface drainageways suggests the possibility that nitrate in the surface waters could contribute to the nitrate levels observed in the shallow wells. Two factors weigh against the surface streams as consistent nitrate sources:

1. Well A-2-s is not proximal to any drainageway, yet nitrate values were quite high.
2. The highest nitrate levels of the study were recorded in early January. Precipitation had not occurred for 7 or more days prior to sampling, and no rainfall occurred during the sampling

run. Thus, it is likely that surface drainageways were fairly dry for several days before the fith sampling.

Certainly, nitrate sources other than seepage pit effluent cannot be entirely discounted. However, it is likely that much of the nitrate pollution observed in Phase 2 sampling was derived from subsurface wastewater discharges.

4.5.8 Fecal Coliform Bacteria and MBAS Observations

Fecal coliform and MBAS observations generally lend authority to the suggestion that all depths of the aquifer are influenced by seepage pit effluent. Widespread contamination by fecal bacteria was observed at most of the sampling times, with the most severe problems being evident at the times of the second and third sampling runs. Widespread detection of MBAS occurred in the second and third sampling runs, associated with generally exhibited high fluoride values. However, the general, sustained rise in MBAS concentration observed in the spring and summer of 1980 was not accompanied by rising fluoride values.

The fluoride, fecal coliform, and MBAS concentrations observed during the groundwater investigation provide strong evidence that the aquifer is being influenced by seepage pit effluent. Regardless of pollutant source, the widespread occurrence of high concentrations of fecal bacteria in groundwater samples represents a clear and present danger to residents who depend upon the aquifer as an untreated drinking water source.

APPENDIX A

Phase 2 Detailed Sample Handling Routine

Routine and IPDWS Parameters

1. Sample preservation - All samples were placed on ice in styrofoam coolers and maintained at 1 - 4°C during transport to the laboratory. No chemical preservatives were added to any samples. Samples in coolers were shipped overnight by United Parcel Service from Louisville to laboratory in Lexington.
2. Holding times - Samples were collected one day, delivered to the laboratory overnight, and unpacked early the next morning.

   Normal first day activities:

   a. Begin coliform incubation.
   b. Assay for nitrate and MBAS.
   c. Filter aliquot to remove suspended solids. Digest and store for metals analyses.

   Chloride and fluoride were tested within 3 to 5 days after collection.

   Samples for pesticide and herbicide assays packed in ice and shipped overnight by air freight to Carborundum. Extraction for analyses carried out within 48 hours after receipt in Sacramento.

APPENDIX B

The laboratory reports concerning priority pollutant assays are presented in this appendix.

The Carborundum Company • R&D/Water Management Division • 3401 LaGrande Blvd., Sacramento, CA 95823

Analysis of Water Samples
For 128 Priority Pollutants

Report Prepared For:

Gannett, Fleming, Corddry, and Carpenter, Inc.

by

THE CARBORUNDUM COMPANY

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James E. Henderson

Approved by: Robert A. Fluegge
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Carborundum SW-1
October 18, 1979

Phone: (916) 421-8700

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I INTRODUCTION

All Tables are presented in Appendix B.

The Carborundum Company is conducting an analytical program for Gannett, Fleming, Corddry, and Carpenter, Inc., to determine the presence of one hundred and twenty-eight (128) Priority Pollutant compounds in water samples taken under the supervision of Commonwealth Technology, Inc. The sampling and analytical program has been scheduled to include a total of six (6) sample sets taken at the rate of two (2) sample sets per month during the months of September and November, 1979 and January, 1980. This initial report includes analytical results for the two (2) sample sets taken during September, 1979.

The Carborundum Company also has responsibilities in this program to supply specially prepared sample bottles and insulated shipping containers for each of the scheduled sampling exercises. Sample bottles are prepared according to EPA recommended techniques which are contained in Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants, U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory Cincinnati, Ohio 45268, March, 1977 revised April, 1977.

On September 13, 1979, two (2) insulated shipping containers were sent to the attention of Dr. Edward Foree of Commonwealth Technology, Inc. by Federal Express. These shipping containers contained the required number of discrete bottles necessary for proper sampling of the parameters being evaluated in this program. Also included with the bottles and shipping containers was a letter to Dr. Foree which included the following items:

1) A list of the parameters to be evaluated together with the volume of sample required and the type and quantity of preservative(s) to be employed for each parameter.
2) Site Characterization Sheets and instructions for their preparation.
3) Sample History Sheets and instructions for their preparation.
4) The necessary paperwork, pre-typed shipping labels, and instructions for the return of the samples and shipping containers by Federal Express.

On Saturday, September 22, 1979, the two (2) insulated shipping containers were received in the Carborundum Analytical Laboratory, Sacramento, California. All samples as received were intact and cold. The shipping containers were placed in cold storage ($4^{o}C$) until Monday, September 24, 1979, at which time they were unpacked and the contents inspected and given internal laboratory designations. Samples designated for metals analyses were forwarded by air, to our analytical laboratories in Lexington, Massachusetts.

Table 1-1 presents information concerning the samples received on September 22, 1979.

II ANALYTICAL METHODOLOGY

The analytical methodology being employed for this program is included as Appendix A.

III ANALYTICAL RESULTS

The reporting format used for the organic priority pollutants, is based on that now used to report priority pollutants to the

U. S. EPA. Three types of symbols are used:

1. Numerical values are reported for acid, base/neutral, and volatile (purgeable) compounds whose concentrations are determined to be over 10 μg/l, or 100 μg/l for acrolein or acrylonitrile. Pesticides determined to be present at concentrations above 5 μg/l are confirmed qualitatively by GC/MS/DS before reporting a numerical quantitative value.
2. The symbol, "*", is used for acids, base/neutrals, and volatiles (purgeables) to indicate that a trace of the compound was detected, but the quantity was too low to accurately quantitate using the procedures outlined in the screening protocol. For pesticides, a "*" indicates that a peak appeared in the chromatographic analysis at the same retention time as a priority pollutant pesticide, but the quantitative calculation showed the concentration to be below 5 μg/l. Such peaks are not confirmed qualitatively by GC/MS/DS to be the pesticides in question, and therefore one should consider the presence of these pesticides in the water samples as only a possibility.
3. The symbol, "N/D", indicates no trace of the compound was detected, and that the sensitivity of the analytical equipment was adjusted to obtain a minimum detection limit of at least 10 μg/l for acids, base/neutrals, and volatiles (purgeables), at least 100 μg/l for acrolein and acrylonitrile, and at least 5 μg/l for the individual pesticides.

Section I of Appendix B presents the analytical results for the extractable (acid/ base/neutral, and pestice) and volatile organic priority pollutants.

Table 1-2 presents the analytical results for cyanide and phenol.

V. DISCUSSION

With the exception of the results for metals, the Carborundum Company has completed the analytical requirements on two sets of water samples. These two sets of samples are part of a program totalling six sample sets.

APPENDIX

Analytical Methods

5.

PRIORITY POLLUTANT ANALYTICAL PROTOCOL

I. Extractable Organic Priority Pollutant Analyses.

The acid, base/neutral, and pesticide priority pollutants were analyzed according to the April, 1977 revision of Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants, U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio 45268.

The samples were refrigerated at $4^{\circ}C$ until the time of extraction. The acids and base/neutrals were extracted with methylene chloride after the appropriate pH adjustments of the water samples were made. The extracts were then concentrated to 1 ml. using standard Kuderna-Danish evaporation equipment. Each acid and base/neutral concentrate was spiked with 10 μl of a 2000 ppm solution of anthracene-d_{10} in methylene chloride. This compound served as the internal standard for improved precision and accuracy.

The concentrates were analyzed using a Finnigan 4000 gas chromatograph/mass spectrometer system. The data were acquired with a Finnigan Incos 2300 computerized data system. The GC/MS/DS system was first certified according to the EPA protocol using the compound, decafluorotriphenylphosphine. The chromatographic performance of the system was then further checked using benzidine or pentachlorophenol for base/neutral or acid fractions, respectively. Next, the instrument was calibrated using the appropriate base/neutral and acid standard mixtures.

The samples were then analyzed, and the concentrations of all observed priority pollutants were calculated using the standards as references.

The pesticide samples were extracted according to the EPA protocol using 15% methylene chloride in hexane. The extracts were then concentrated using standard Kuderna-Danish equipment. The concentrates were analyzed on a Varian 3700 gas chromatograph equipped with dual electron capture detectors. The instrument was first calibrated using a priority pollutant pesticide standard mixture.

II. Volatile Organic Priority Pollutant Analyses.

The VOA water samples were refrigerated at 4°C until they were analyzed directly by placing a five (5) ml. aliquot of each water sample into a Bellar-type purging device which allowed the "purged" volatile organic compounds to be transferred to the Finnigan 4000 GC/MS/DS system.

Prior to analysis, the system is certified according to the EPA protocol using pentafluorobromobenzene.

The system was then calibrated using a standard mixture containing the volatile priority pollutants. After the samples were analyzed, the concentrations of all observed volatile priority pollutants were calculated using the volatile standard.

CLASSICAL PRIORITY POLLUTANT PARAMETER ANALYSES

III. Total Phenols.

The phenols analyses were performed according to the following reference in the EPA priority pollutant protocol: Standard Methods for the Examination of Water and Wastewater, 14th Edition, 1975, Method 510, pp. 576. In accordance with the method, the samples were distilled and reacted with 4-aminoantipyrene. The resulting product was extracted with chloroform and quantitated spectrophotometrically at a wavelength of 460 nanometers.

IV. Cyanide Analysis.

The cyanide samples were distilled and reacted with chloramine T, and then pyridine-pyrazolone to form a colored complex which could be quantitated spectrophotometrically at 620 nanometers as per the procedure outlined in Methods for Chemical Analysis of Water and Wastes, (1979), U.S. EPA, Technology Transfer pp. 43 - 48.

V. Metals Analyses.

The metals samples were analyzed according to the following reference: Methods of Chemical Analysis of Water and Wastes, (op. cit.). A combination of flame and flameless atomic absorption techniques were used as required for each metal. Mercury was analyzed by a "cold cell" flameless atomic absorption method outlined in the same reference.

APPENDIX B

Table 1-1; Summary of Samples Submitted

Section 1; Extractable and Volatile Organic Compound Results

Table 1-2; Cyanide and Phenol Results

TABLE 1 - 1

Summary of Samples Submitted (1) for Gannett, Fleming, Corddry, and Carpenter, Inc.

PROJECT SW

Sample Identification	Laboratory Number	Parameter(s) Evaluated	Volume of Sample Submitted
SW-A-2-S-a	1032-1	Extractable organics (acid, base/neutral, and pesticide compounds)	1 gallon (glass)
SW-B-2-S-a	1032-2	Extractable organics (acid, base/neutral, and pesticide compounds)	1 gallon (glass)
SW-A-2-S-b	1032-3	Volatile Organic Compounds (VOA)	2 - 40 ml bottles (glass)
VOA Trip Blank	1032-4	Volatile Organic Compounds (VOA)	1 - 40 ml bottle (glass)
SW-B-2-S-b	1032-5	Volatile Organic Compounds (VOA)	2 - 40 ml bottle (glass)
VOA Trip Blank	1032-6	Volatile Organic Compounds (VOA)	1 - 40 ml bottle (glass)
SW-A-2-S-c	1032-7	Cyanide	1 quart (plastic)
SW-B-2-S-c	1032-8	Cyanide	1 quart (plastic)
SW-A-2-S-d	1032-9	Phenols	1 quart (amber glass
SW-B-2-S-d	1032-10	Phenols	1 quart (amber glass
SW-A-2-S-e	1032-11	Metals	1 quart (plastic)
SW-B-2-S-e	1032-12	Metals	1 quart (plastic)

(1) Sample bottles for asbestos determinations were inadvertantly sent to Commonwealth Technology, Inc. but analyses are not required.

THE C BORUNDUM ANALYTICAL LABOR RY

ACID FRACTION		BASE/NEUTRAL FRACTION	
IPLE ID	SW-A-2-S-A	SAMPLE ID	SW-A-2-S-A
ID	1032-1A	LAB ID	1032-1B
TE EXTRACTED	9-24-79	DATE EXTRACTED	9-24-79
TE INJECTED	9-27-79	DATE INJECTED	9-27-79
. ID	A20927	STD. ID	B20927
NC. FACTOR	1700	CONC. FACTOR	1700

ACID COMPOUNDS	µg/l
2,4,6- trichlorophenol	*
p-chloro-m-cresol	ND
2- chlorophenol	ND
2,4-dichlorophenol	*
2,4- dimethylphenol	ND
2- nitrophenol	ND
4- nitrophenol	ND
2,4- dinitrophenol	ND
4,6- dinitro-o-cresol	ND
pentachlorophenol	ND
phenol	ND

BASE/NEUTRAL COMPOUNDS	
acenaphthene	ND
benzidine	ND
1,2,3- trichlorobenzene	ND
hexachlorobenzene	ND
hexachloroethane	ND
bis(2-chloroethyl)ether	ND
2-chloronaphthalene	ND
1,2-dichlorobenzene	ND
1,3-dichlorobenzene	ND
1,4-dichlorobenzene	ND
3,3'-dichlorobenzidine	ND
2,4- dinitrotoluene	ND
2,6- dinitrotoluene	ND
1,2- diphenylhydrazine (as azobenzene)	ND
fluoranthene	ND
4- chlorophenyl phenyl ether	ND

	BASE/NEUTRAL COMPOUNDS	µg/l
41B	4-bromophenyl phenyl ether	ND
42B	bis (2-chloroisopropyl) ether	ND
43B	bis (2-chloroethoxy) methane	ND
52B	hexachlorobutadiene	ND
53B	hexachlorocyclopentadiene	ND
54B	isophorone	ND
55B	naphthalene	ND
56B	nitrobenzene	ND
61B	N-nitrosodimethylamine	ND
62B	N-nitrosodiphenylamine	ND
63B	N-nitrosodi-n-propylamine	ND
66B	bis (2-ethylhexyl) phthalate	87
67B	butyl benzyl phthalate	*
68B	di-n-butyl phthalate	19
69B	di-n-octyl phthalate	*
70B	diethyl phthalate	*
71B	dimethyl phthalate	*
72B	benzo(a)anthracene	ND
73B	benzo(a)pyrene	ND
74B	3,4-benzofluoranthene	ND
75B	benzo(k)fluoranthene	ND
76B	chrysene	ND
77B	acenaphthylene	ND
78B	anthracene	ND
79B	benzo(ghi)perylene	ND
80B	fluorene	ND
81B	phenanthrene	ND
82B	dibenzo(a,h)anthracene	ND
83B	indeno(1,2,3-cd)pyrene	ND
84B	pyrene	ND
129B	2,3,7,8-tetrachlorodibenzo-p-dioxin	ND

THE CARBORUNDUM ANALYTICAL LABORATORY

100
VOLATILE FRACTION

APLE ID SW-A-2-S-B
B ID 1032-3V
TE INJECTED 9-27-79
. ID V40927
NC. FACTOR 1

PESTICIDE FRACTION

SAMPLE ID SW-A-2-S-A
LAB ID 1032-1P
DATE EXTRACTED 9-24-79
DATE INJECTED 10-3-79
STD. ID P1003
CONC. FACTOR 8

	VOLATILES	µg/l
	acrolein	ND
	acrylonitrile	ND
	benzene	*
	carbon tetrachloride	ND
	chlorobenzene	ND
/	1,2-dichloroethane	ND
V	1,1,1-trichloroethane	*
V	1,1-dichloroethane	ND
V	1,1,2-trichloroethane	ND
V	1,1,2,2-tetrachloroethane	ND
V	chloroethane	ND
V	bis (chloromethyl) ether	ND
V	2-chloroethylvinyl ether	ND
V	chloroform	*
V	1,1-dichloroethylene	ND
V	1,2-trans-dichloroethylene	ND
V	1,2-dichloropropane	ND
V	1,3-dichloropropylene	ND
V	ethylbenzene	*
V	methylene chloride	61
V	methyl chlorid	ND
V	methyl bromide	ND
V	bromoform	ND
V	dichlorobromomethane	ND
V	trichlorofluoromethane	ND
V	dichlorodifluoromethane	ND
V	chlorodibromomethane	ND
V	tetrachloroethylene	*
V	toluene	*
V	trichloroethylene	*
V	vinyl chloride	ND

	PESTICIDES	µg/l
89P	aldrin	ND
90P	dieldrin	ND
91P	chlordane	ND
92P	4,4'-DDT	ND
93P	4,4'-DDE	ND
94P	4,4'-DDD	ND
95P	α-endosulfan	ND
96P	β-endosulfan	ND
97P	endosulfan sulfate	ND
98P	endrin	ND
99P	endrin aldehyde	ND
100P	heptachlor	*
101P	heptachlor epoxide	ND
102P	α-BHC	ND
103P	β-BHC	ND
104P	γ-BHC	ND
105P	δ-BHC	ND
106P	PCB-1242	ND
107P	PCB-1254	ND
108P	PCB-1221	ND
109P	PCB-1232	ND
110P	PCB-1248	ND
111P	PCB-1260	ND
112P	PCB-1016	ND
113P	toxaphene	ND

* = Less than 10 ug/l (pesticides less than 5 ug/l, and not confirmed by GC/MS).

ND = Not detected

1/31/79

THE 'RBORUNDUM ANALYTICAL LABO TORY

ACID FRACTION		BASE/NEUTRAL FRACTION	
AMPLE ID	SW-B-2-S-A	SAMPLE ID	SW-B-2-S-A
AB ID	1032-2A	LAB ID	1032-2B
ATE EXTRACTED	9-24-79	DATE EXTRACTED	9-24-79
ATE INJECTED	9-27-79	DATE INJECTED	9-27-79
TD. ID	A20927	STD. ID	B20927
ONC. FACTOR	1700	CONC. FACTOR	1700

	ACID COMPOUNDS	µg/l
A	2,4,6- trichlorophenol	*
2A	p-chloro-m-cresol	ND
A	2- chlorophenol	ND
A	2,4-dichlorophenol	ND
A	2,4- dimethylphenol	ND
A	2- nitrophenol	*
A	4- nitrophenol	ND
A	2,4- dinitrophenol	ND
A	4,6- dinitro-o-cresol	ND
A	pentachlorophenol	ND
A	phenol	ND

BASE/NEUTRAL COMPOUNDS	
acenaphthene	ND
benzidine	ND
1,2,3- trichlorobenzene	ND
hexachlorobenzene	ND
hexachloroethane	ND
bis(2-chloroethyl)ether	ND
2-chloronaphthalene	ND
1,2-dichlorobenzene	ND
1,3-dichlorobenzene	ND
1,4-dichlorobenzene	ND
3,3'-dichlorobenzidine	ND
2,4- dinitrotoluene	ND
2,6- dinitrotoluene	ND
1,2- diphenylhydrazine (as azobenzene)	ND
fluoranthene	ND
4- chlorophenyl phenyl ether	ND

	BASE/NEUTRAL COMPOUNDS	µg/l
41B	4-bromophenyl phenyl ether	ND
42B	bis (2-chloroisopropyl) ether	ND
43B	bis (2-chloroethoxy) methane	ND
52B	hexachlorobutadiene	ND
53B	hexachlorocyclopentadiene	ND
54B	isophorone	ND
55B	naphthalene	ND
56B	nitrobenzene	ND
61B	N-nitrosodimethylamine	ND
62B	N-nitrosodiphenylamine	ND
63B	N-nitrosodi-n-propylamine	ND
66B	bis (2-ethylhexyl) phthalate	34
67B	butyl benzyl phthalate	*
68B	di-n-butyl phthalate	23
69B	di-n-octyl phthalate	*
70B	diethyl phthalate	*
71B	dimethyl phthalate	*
72B	benzo(a)anthracene	ND
73B	benzo(a)pyrene	ND
74B	3,4-benzofluoranthene	ND
75B	benzo(k)fluoranthene	ND
76B	chrysene	ND
77B	acenaphthylene	ND
78B	anthracene	ND
79B	benzo(ghi)perylene	ND
80B	fluorene	ND
81B	phenanthrene	ND
82B	dibenzo(a,h)anthracene	ND
83B	indeno(1,2,3-cd)pyrene	ND
84B	pyrene	ND
129B	2,3,7,8-tetrachlorodibenzo-p-dioxin	ND

THE CARBORUNDUM ANALYTICAL LABORATORY

102
VOLATILE FRACTION

PLE ID SW-B-2-S-B
ID 1032-5V
TE INJECTED 9-27-79
. ID V40927
NC. FACTOR 1

PESTICIDE ACTION

SAMPLE ID SW-B-2-S-A
LAB ID 1032-2P
DATE EXTRACTED 9-24-79
DATE INJECTED 10-3-79
STD. ID P1003
CONC. FACTOR 8

VOLATILES	μg/l
acrolein	ND
acrylonitrile	ND
benzene	*
carbon tetrachloride	ND
chlorobenzene	ND
1,2-dichloroethane	ND
1,1,1-trichloroethane	ND
1,1-dichloroethane	ND
1,1,2-trichloroethane	ND
1,1,2,2-tetrachloroethane	ND
chloroethane	ND
bis (chloromethyl) ether	ND
2-chloroethylvinyl ether	ND
chloroform	*
1,1-dichloroethylene	ND
1,2-trans-dichloroethylene	ND
1,2-dichloropropane	ND
1,3-dichloropropylene	ND
ethylbenzene	*
methylene chloride	330
methyl chlorid	ND
methyl bromide	ND
bromoform	ND
dichlorobromomethane	ND
trichlorofluoromethane	ND
dichlorodifluoromethane	ND
chlorodibromomethane	ND
tetrachloroethylene	*
toluene	*
trichloroethylene	*
vinyl chloride	ND

	PESTICIDES	μg/l
89P	aldrin	ND
90P	dieldrin	ND
91P	chlordane	ND
92P	4,4'-DDT	ND
93P	4,4'-DDE	ND
94P	4,4'-DDD	ND
95P	α-endosulfan	ND
96P	β-endosulfan	ND
97P	endosulfan sulfate	ND
98P	endrin	ND
99P	endrin aldehyde	ND
100P	heptachlor	*
101P	heptachlor epoxide	ND
102P	α-BHC	ND
103P	β-BHC	ND
104P	γ-BHC	ND
105P	δ-BHC	ND
106P	PCB-1242	ND
107P	PCB-1254	ND
108P	PCB-1221	ND
109P	PCB-1232	ND
110P	PCB-1248	ND
111P	PCB-1260	ND
112P	PCB-1016	ND
113P	toxaphene	ND

* = Less than 10 ug/l
(pesticides less than 5 ug/l, and not confirmed by GC/MS).

ND = Not detected

1/31/79

THE CARBORUNDUM ANALYTICAL LABORATORY

VOLATILE FRACTION

AMPLE ID VOA TRIP BLANK
AB ID 1032-4V
ATE INJECTED 9-27-79
D. ID V40927
ONC. FACTOR 1

PESTICIDE FRACTION

SAMPLE ID
LAB ID
DATE EXTRACTED
DATE INJECTED
STD. ID
CONC. FACTOR

	VOLATILES	µg/l		PESTICIDES		µg/l
	acrolein	ND	89P	aldrin		
	acrylonitrile	ND	90P	dieldrin		
	benzene	*	91P	chlordane		
	carbon tetrachloride	ND	92P	4,4'-DDT		
	chlorobenzene	ND	93P	4,4'-DDE		
V	1,2-dichloroethane	ND	94P	4,4'-DDD		
V	1,1,1-trichloroethane	16	95P	α-endosulfan	NOT REQUIRED	
V	1,1-dichloroethane	ND	96P	β-endosulfan		
V	1,1,2-trichloroethane	ND	97P	endosulfan sulfate		
V	1,1,2,2-tetrachloroethane	ND	98P	endrin		
V	chloroethane	ND	99P	endrin aldehyde		
V	bis (chloromethyl) ether	ND	100P	heptachlor		
V	2-chloroethylvinyl ether	ND	101P	heptachlor epoxide		
V	chloroform	ND	102P	α-BHC		
V	1,1-dichloroethylene	ND	103P	β-BHC		
V	1,2-trans-dichloroethylene	ND	104P	γ-BHC		
	1,2-dichloropropane	ND	105P	δ-BHC		
	1,3-dichloropropylene	ND	106P	PCB-1242		
	ethylbenzene	ND	107P	PCB-1254		
	methylene chloride	*	108P	PCB-1221		
	methyl chlorid	ND	109P	PCB-1232		
	methyl bromide	ND	110P	PCB-1248		
	bromoform	ND	111P	PCB-1260		
	dichlorobromomethane	ND	112P	PCB-1016		
	trichlorofluoromethane	ND	113P	toxaphene		
	dichlorodifluoromethane	ND				
	chlorodibromomethane	ND				
	tetrachloroethylene	ND				
	toluene	*				
	trichloroethylene	ND				
	vinyl chloride	ND				

* = Less than 10 ug/l
(pesticides less than 5 ug/l, and not confirmed by GC/MS).

ND = Not detected

TABLE 1-2

Cyanide and Phenols Analysis

Samples Analyzed for:

Gannett Fleming Corddry & Carpenter, Inc.

PROJECT SW

Sample I.D.	Cyanide (μg/l)	Phenols (μg/l)
SW-A-2-S-C	37	
SW-B-2-S-C	17	
SW-A-2-S-D		<5
SW-B-2-S-D		<5

The Carborundum Company • R&D/Water Management Division • 3401 LaGrande Blvd., Sacramento, CA 95823

Analysis of Water Samples

For Priority Pollutants

Report Prepared For:

Gannett, Fleming, Corddry and Carpenter, Inc.

by

THE CARBORUNDUM COMPANY

Prepared by: Robert E. Meierer
Robert E. Meierer

Approved by: Robert A. Fluegge
Robert A. Fluegge

Carborundum SW-2
October 30, 1979

Phone: (916) 421-8700

TABLE OF CONTENTS

Section	Description	Page
I	Introduction	1.
II	Analytical Methodology	1.
III	Analytical Results	1.
IV	Discussion	1.

I. INTRODUCTION

All Tables are presented in the Appendix.

Carborundum Report SW-1 contains analytical results for extractable organic compounds, volatile organic compounds, cyanide and phenols, determined on the same two water samples being reported here.

Table 2-1 presents information concerning the samples submitted for metals analyses on September 13, 1979. This information is excerpted from Table 1-1 of Carborundum Report SW-1.

II. ANALYTICAL METHODOLOGY

See Carborundum Report SW-1 for details of the Analytical Methodology.

III. ANALYTICAL RESULTS

Table 2-2 presents the results for the following metals in two water samples: arsenic, antimony, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc.

IV. DISCUSSION

The Carborundum Company has completed the analytical requirements on the first two sets of water samples in a program totalling six (6) sample sets.

APPENDIX

2.

Table 2-1

Summary of Samples Taken for Metals Analyses

Project SW

Sample Identification	Lab Numbers	Parameter(s) Evaluated	Volume of Sample Submitted
SW-A-2-S-e	1032-11 (27071)(1)	Metals	1 quart (plastic)
SW-B-2-S-e	1032-12 (27072)(1)	Metals	1 quart (plastic)

---

(1) Laboratory number assigned to sample by our analytical laboratory performing the metals analyses.

Table 2-2

Analytical Results: Metals

Project SW

(concentration in mg/l)

Sample Identification	SW-A-2-S-e	SW-B-2-S-e
Lab Numbers	1032-11; 27071	1032-12; 27072
Arsenic	0.002	0.001
Antimony	0.002	0.002
Beryllium	<0.002	<0.002
Cadmium	<0.002	<0.002
Chromium	<0.002	<0.002
Copper	0.009	0.004
Lead	0.025	0.024
Mercury	0.0004	<0.0003
Nickel	<0.005	<0.005
Selenium	<0.002	<0.002
Silver	0.002	0.002
Thallium	<0.005	<0.005
Zinc	3.68	1.32

The Carborundum Company • R&D/Water Management Division • 3401 LaGrande Blvd., Sacramento, CA 95823

Analysis of Water Samples
For Priority Pollutants

Report Prepared for

Gannett, Fleming, Corddry and Carpenter, Inc.

by

THE CARBORUNDUM COMPANY

Prepared by: Robert E. Meierer
Robert E. Meierer

Data Certified by: James E. Henderson
James E. Henderson

Approved by: Robert A. Fluegge
Robert A. Fluegge

Carborundum SW-3
December 26, 1979

Phone: (916) 421-8700

Table of Contents

Section	Description	Page #
I	Introduction	1
II	Analytical Methodology	1
III	Analytical Results	2
IV	Discussion	2

I. INTRODUCTION

All Tables are presented in the Appendix.

The Carborundum Company is conducting an analytical program for Gannett, Fleming, Corddry and Carpenter, Inc., to determine the presence of one hundred and twenty-eight (128) Priority Pollutant compounds in water samples. The water samples are being taken under the supervision of Commonwealth Technology, inc., of Lexington, Kentucky.

This report contains the analytical results for two sample sets taken during the month of November, 1979. Analytical results for samples taken in September 1979, were contained in Carborundum Reports SW-1 and SW-2 dated October 18, 1979 and October 30, 1979, respectively.

On November 29, 1979, two (2) insulated shipping containers were received in the Carborundum Analytical Laboratory, Sacramento, California. The containers were immediately unpacked, and the contents inspected and given internal laboratory designations. All samples were received cold and intact. Ice, used for preservation of the samples during shipment, was still apparent in the shipping containers.

Table 3-1 presents information concerning the samples received on November 29, 1979.

II. ANALYTICAL METHODOLOGY

The analytical methodology being employed in this program has been detailed in Carborundum Report SW-1, dated October 19, 1979.

III. ANALYTICAL RESULTS

The reporting format used for organic Priority Pollutants has been detailed in the aforementioned report, SW-1.

Section I of the Appendix presents the analytical results for the extractable (acid, base/neutral and pesticide) and volatile organic Priority Pollutants.

Table 3-2 presents the analytical results for cyanide and phenols, both determined colorimetrically.

Table 3-3 presents the analytical results for metals.

IV. DISCUSSION

The Carborundum Company has completed the analytical requirements on the second sets of samples submitted on this analytical program. The total program encompasses six sample sets and the last two sets of samples are scheduled to be submitted for analysis during January, 1980.

Table 3-1

Summary of Samples Submitted
for
Gannett, Fleming, Corddry, and Carpenter, Inc.

Project SW

Sample Identification	Laboratory Number	Parameter(s) Evaluated	Volume of Sample Submitted
SW-A-2-S-EO	1063-9	Extractable Organics (acid, base/neutral & pesticide compounds)	1-gallon (glass)
SW-C-3-S-EO	1063-3	Extractable Organics (acid, base/neutral & pesticide compounds)	1-gallon (glass)
SW-A-2-S-VO	1063-11	Volatile Organic Compound (VOA)	2-25 ml. bottles (glass)
VOA Trip Blank	1063-12	Volatile Organic Compound (VOA)	1-25 ml.bottle (glass)
SW-C-3-S-VO	1063-6	Volatile Organic Compound (VOA)	2-25 ml. bottles (glass)
VOA Trip Blank	1063-5	Volatile Organic Compound (VOA)	1-25 ml. bottle (glass)
SW-A-2-S-C	1063-7	Cyanide	1-quart (plastic)
SW-C-3-S-C	1063-1	Cyanide	1-quart (plastic)
SW-A-2-S-P	1063-10	Phenols	1-quart (amber glass
SW-C-3-S-P	1063-4	Phenols	1-quart (amber glass
SW-A-2-S-M	1063-8	Metals	1-quart (plastic)
SW-C-3-S-M	1063-2	Metals	1-quart (plastic)

Table 3-2

Analytical Results: Cyanide and Phenols

Samples Analyzed for

Gannett, Fleming, Corddry, and Carpenter, Inc.

Project SW

Sample I.D.	Cyanide (μg/l)	Phenols (μg/l)
SW-A-2-S-C	12	-
SW-C-3-S-C	<5	-
SW-A-2-S-P	-	2
SW-C-3-S-P	-	<1

Table 3-3

Analytical Results: Metals

Samples Analyzed for

Gannett, Fleming, Corddry and Carpenter, Inc.

Project SW

(concentration in mg/l)

Sample Identification Lab Numbers	SW-A-2-S-M 1063-8; 79-2638	SW-C-3-S-M 1063-2; 79-2637
Arsenic	0.001	<0.001
Antimony	<0.002	<0.002
Beryllium	<0.001	<0.001
Cadmium	0.003	<0.001
Chromium	<0.001	<0.001
Copper	0.003	0.002
Lead	<0.001	<0.001
Mercury	<0.0002	<0.0002
Nickel	0.021	0.004
Selenium	<0.001	<0.001
Silver	0.001	<0.001
Thallium	<0.001	<0.002
Zinc	2.51	1.39

THE CARBORUNDUM ANALYTICAL LABORATORY

118 ACID FRACTION

MPLE ID SW-A-2-S-EO
B ID 1063-9A
TE EXTRACTED 11/30/79
TE INJECTED 12/3/79
D. ID A41203A
NC. FACTOR 1700

BASE/NEUTRAL FRACTION

SAMPLE ID SW-A-2-S-EO
LAB ID 1063-9B
DATE EXTRACTED 11/30/79
DATE INJECTED 12/5/79
STD. ID B41205
CONC. FACTOR 1700

	ACID COMPOUNDS	µg/l
A	2,4,6- trichlorophenol	N/D
A	p-chloro-m-cresol	N/D
A	2- chlorophenol	N/D
1A	2,4-dichlorophenol	*
A	2,4- dimethylphenol	N/D
7A	2- nitrophenol	N/D
A	4- nitrophenol	N/D
9A	2,4- dinitrophenol	N/D
0A	4,6- dinitro-o-cresol	N/D
4A	pentachlorophenol	N/D
5A	phenol	*

	BASE/NEUTRAL COMPOUNDS	
B	acenaphthene	N/D
B	benzidine	N/D
B	1,2, 4-trichlorobenzene	N/D
B	hexachlorobenzene	N/D
2B	hexachloroethane	N/D
3B	bis(2-chloroethyl)ether	N/D
0B	2-chloronaphthalene	N/D
5B	1,2-dichlorobenzene	N/D
6B	1,3-dichlorobenzene	N/D
7B	1,4-dichlorobenzene	N/D
8B	3,3'-dichlorobenzidine	N/D
5B	2,4- dinitrotoluene	N/D
6B	2,6- dinitrotoluene	N/D
7B	1,2- diphenylhydrazine (as azobenzene)	N/D
9B	fluoranthene	N/D
0B	4- chlorophenyl phenyl ether	N/D

	BASE/NEUTRAL COMPOUNDS	µg/l
41B	4-bromophenyl phenyl ether	N/D
42B	bis (2-chloroisopropyl) ether	N/D
43B	bis (2-chloroethoxy) methane	N/D
52B	hexachlorobutadiene	N/D
53B	hexachlorocyclopentadiene	N/D
54B	isophorone	N/D
55B	naphthalene	N/D
56B	nitrobenzene	N/D
61B	N-nitrosodimethylamine	N/D
62B	N-nitrosodiphenylamine	N/D
63B	N-nitrosodi-n-propylamine	N/D
66B	bis (2-ethylhexyl) phthalate	*
67B	butyl benzyl phthalate	N/D
68B	di-n-butyl phthalate	*
69B	di-n-octyl phthalate	N/D
70B	diethyl phthalate	N/D
71B	dimethyl phthalate	N/D
72B	benzo(a)anthracene	N/D
73B	benzo(a)pyrene	N/D
74B	3,4-benzofluoranthene	N/D
75B	benzo(k)fluoranthene	N/D
76B	chrysene	N/D
77B	acenaphthylene	N/D
78B	anthracene	N/D
79B	benzo(ghi)perylene	N/D
80B	fluorene	N/D
81B	phenanthrene	N/D
82B	dibenzo(a,h)anthracene	N/D
83B	indeno(1,2,3-cd)pyrene	N/D
84B	pyrene	N/D
129B	2,3,7,8-tetrachlorodibenzo-p-dioxin	N/

[illegible] ANALYTICAL LABORATORY

VOLATILE FRACTION

MPLE ID	SW-A-2-S-VO
AB ID	1063-11V
ATE INJECTED	11/30/79
D. ID	V41130
NC. FACTOR	1

PESTICIDE FRACTION

SAMPLE ID	SW-A-2-S-EO
LAB ID	1063-9P
DATE EXTRACTED	11/30/79
DATE INJECTED	12/27/79
STD. ID	P1227
CONC. FACTOR	16

	VOLATILES	μg/l
V	acrolein	N/D
V	acrylonitrile	N/D
V	benzene	N/D
V	carbon tetrachloride	N/D
V	chlorobenzene	N/D
V	1,2-dichloroethane	N/D
V	1,1,1-trichloroethane	N/D
3V	1,1-dichloroethane	N/D
V	1,1,2-trichloroethane	N/D
V	1,1,2,2-tetrachloroethane	N/D
6V	chloroethane	N/D
7V	bis (chloromethyl) ether	N/D
9V	2-chloroethylvinyl ether	N/D
3V	chloroform	*
9V	1,1-dichloroethylene	N/D
0V	1,2-trans-dichloroethylene	N/D
2V	1,2-dichloropropane	N/D
3V	1,3-dichloropropylene	N/D
V	ethylbenzene	*
V	methylene chloride	N/D
V	methyl chlorid	N/D
V	methyl bromide	*
V	bromoform	N/D
V	dichlorobromomethane	N/D
V	trichlorofluoromethane	N/D
V	dichlorodifluoromethane	N/D
V	chlorodibromomethane	N/D
V	tetrachloroethylene	N/D
V	toluene	*
V	trichloroethylene	N/D
	vinyl chloride	N/D

	PESTICIDES	μg/l
89P	aldrin	N/D
90P	dieldrin	N/D
91P	chlordane	N/D
92P	4,4'-DDT	N/D
93P	4,4'-DDE	*
94P	4,4'-DDD	N/D
95P	α-endosulfan	N/D
96P	β-endosulfan	N/D
97P	endosulfan sulfate	*
98P	endrin	N/D
99P	endrin aldehyde	N/D
100P	heptachlor	N/D
101P	heptachlor epoxide	N/D
102P	α-BHC	*
103P	β-BHC	N/D
104P	γ-BHC	N/D
105P	δ-BHC	N/D
106P	PCB-1242	N/D
107P	PCB-1254	N/D
108P	PCB-1221	N/D
109P	PCB-1232	N/D
110P	PCB-1248	N/D
111P	PCB-1260	N/D
112P	PCB-1016	N/D
113P	toxaphene	N/D

* = Less than 10 ug/l
(pesticides less than 5 ug/l, and
not confirmed by GC/MS).

ND = Not detected

120 ACID FRACTION

AMPLE ID SW-C-3-S-EO
AB ID 1063-3A
ATE EXTRACTED 11/30/79
ATE INJECTED 12/3/79
TD. ID A41203A
ONC. FACTOR 1700

ACID COMPOUNDS		µg/l
21A	2,4,6- trichlorophenol	N/D
22A	p-chloro-m-cresol	N/D
24A	2- chlorophenol	N/D
31A	2,4-dichlorophenol	N/D
34A	2,4- dimethylphenol	N/D
57A	2- nitrophenol	N/D
58A	4- nitrophenol	N/D
59A	2,4- dinitrophenol	N/D
60A	4,6- dinitro-o-cresol	N/D
64A	pentachlorophenol	N/D
65A	phenol	*

BASE/NEUTRAL COMPOUNDS		
1B	acenaphthene	N/D
5B	benzidine	N/D
8B	1,2, 4-trichlorobenzene	N/D
9B	hexachlorobenzene	N/D
12B	hexachloroethane	N/D
18B	bis(2-chloroethyl)ether	N/D
20B	2-chloronaphthalene	N/D
25B	1,2-dichlorobenzene	N/D
26B	1,3-dichlorobenzene	N/D
27B	1,4-dichlorobenzene	N/D
28B	3,3'-dichlorobenzidine	N/D
35B	2,4- dinitrotoluene	N/D
36B	2,6- dinitrotoluene	N/D
37B	1,2- diphenylhydrazine (as azobenzene)	N/D
39B	fluoranthene	N/D
40B	4- chlorophenyl phenyl ether	N/D

BASE/NEUTR/ FRACTION

SAMPLE ID SW-C-3-S-EO
LAB ID 1063-3B
DATE EXTRACTED 11/30/79
DATE INJECTED 12/5/79
STD. ID B41205
CONC. FACTOR 1700

BASE/NEUTRAL COMPOUNDS		µg/l
41B	4-bromophenyl phenyl ether	N/D
42B	bis (2-chloroisopropyl) ether	N/D
43B	bis (2-chloroethoxy) methane	N/D
52B	hexachlorobutadiene	N/D
53B	hexachlorocyclopentadiene	N/D
54B	isophorone	N/D
55B	naphthalene	N/D
56B	nitrobenzene	N/D
61B	N-nitrosodimethylamine	N/D
62B	N-nitrosodiphenylamine	N/D
63B	N-nitrosodi-n-propylamine	N/D
66B	bis (2-ethylhexyl) phthalate	*
67B	butyl benzyl phthalate	N/D
68B	di-n-butyl phthalate	*
69B	di-n-octyl phthalate	N/D
70B	diethyl phthalate	N/D
71B	dimethyl phthalate	N/D
72B	benzo(a)anthracene	N/D
73B	benzo(a)pyrene	N/D
74B	3,4-benzofluoranthene	N/D
75B	benzo(k)fluoranthene	N/D
76B	chrysene	N/D
77B	acenaphthylene	N/D
78B	anthracene	N/D
79B	benzo(ghi)perylene	N/D
80B	fluorene	N/D
81B	phenanthrene	N/D
82B	dibenzo(a,h)anthracene	N/D
83B	indeno(1,2,3-cd)pyrene	N/D
84B	pyrene	N/D
129B	2,3,7,8-tetrachlorodibenzo-p-dioxin	N/

[illegible]

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VOLATILE FRACTION

MPLE ID SW-C-3-S-VO

B ID 1063-6V

TE INJECTED 11/30/79

D. ID V41130

NC. FACTOR 1

PESTICIDE FRACTION

SAMPLE ID SW-C-3-[illegible]O

LAB ID 1063-3P

DATE EXTRACTED 11/30/79

DATE INJECTED 12/27/79

STD. ID P1227

CONC. FACTOR 16

	VOLATILES	μg/l
	acrolein	N/D
	acrylonitrile	N/D
	benzene	*
	carbon tetrachloride	N/D
	chlorobenzene	N/D
V	1,2-dichloroethane	N/D
V	1,1,1-trichloroethane	N/D
V	1,1-dichloroethane	N/D
V	1,1,2-trichloroethane	N/D
V	1,1,2,2-tetrachloroethane	N/D
V	chloroethane	N/D
V	bis (chloromethyl) ether	N/D
V	2-chloroethylvinyl ether	N/D
V	chloroform	*
V	1,1-dichloroethylene	N/D
V	1,2-trans-dichloroethylene	N/D
V	1,2-dichloropropane	N/D
V	1,3-dichloropropylene	N/D
V	ethylbenzene	*
V	methylene chloride	*
V	methyl chloride	N/D
V	methyl bromide	N/D
V	bromoform	N/D
V	dichlorobromomethane	N/D
V	trichlorofluoromethane	N/D
V	dichlorodifluoromethane	N/D
V	chlorodibromomethane	N/D
V	tetrachloroethylene	N/D
V	toluene	*
V	trichloroethylene	N/D
V	vinyl chloride	N/D

	PESTICIDES	μg/l
89P	aldrin	N/D
90P	dieldrin	N/D
91P	chlordane	N/D
92P	4,4'-DDT	N/D
93P	4,4'-DDE	N/D
94P	4,4'-DDD	N/D
95P	α -endosulfan	N/D
96P	β -endosulfan	N/D
97P	endosulfan sulfate	*
98P	endrin	N/D
99P	endrin aldehyde	N/D
100P	heptachlor	N/D
101P	heptachlor epoxide	N/D
102P	α -BHC	*
103P	β -BHC	N/D
104P	γ -BHC	N/D
105P	δ -BHC	N/D
106P	PCB-1242	N/D
107P	PCB-1254	N/D
108P	PCB-1221	N/D
109P	PCB-1232	N/D
110P	PCB-1248	N/D
111P	PCB-1260	N/D
112P	PCB-1016	N/D
113P	toxaphene	N/D

* = Less than 10 ug/l
(pesticides less than 5 ug/l, and not confirmed by GC/MS).

ND = Not detected

1/31/79

[illegible] ANALYTICAL LABORATORY

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VOLATILE FRACTION

SAMPLE ID VOA TRIP BLANK
LAB ID 1063-5 V BLK
DATE INJECTED 11/30/79
STD. ID V41130
CONC. FACTOR 1

PESTICIDE FRACTION

SAMPLE ID
LAB ID
DATE EXTRACTED
DATE INJECTED
STD. ID
CONC. FACTOR

	VOLATILES	µg/l
2V	acrolein	N/D
	acrylonitrile	N/D
	benzene	*
	carbon tetrachloride	N/D
	chlorobenzene	N/D
10V	1,2-dichloroethane	N/D
11V	1,1,1-trichloroethane	N/D
13V	1,1-dichloroethane	N/D
14V	1,1,2-trichloroethane	N/D
15V	1,1,2,2-tetrachloroethane	N/D
16V	chloroethane	N/D
17V	bis (chloromethyl) ether	N/D
19V	2-chloroethylvinyl ether	N/D
23V	chloroform	*
29V	1,1-dichloroethylene	N/D
30V	1,2-trans-dichloroethylene	N/D
32V	1,2-dichloropropane	N/D
33V	1,3-dichloropropylene	N/D
38V	ethylbenzene	N/D
44V	methylene chloride	*
45V	methyl chlorid	N/D
46V	methyl bromide	N/D
47V	bromoform	N/D
48V	dichlorobromomethane	N/D
9V	trichlorofluoromethane	N/D
50V	dichlorodifluoromethane	N/D
51V	chlorodibromomethane	N/D
85V	tetrachloroethylene	N/D
86V	toluene	N/D
87V	trichloroethylene	N/D
88V	vinyl chloride	N/D

	PESTICIDES	µg/l
89P	aldrin	
90P	dieldrin	
91P	chlordane	
92P	4,4'-DDT	
93P	4,4'-DDE	
94P	4,4'-DDD	
95P	α -endosulfan	
96P	β -endosulfan	
97P	endosulfan sulfate	
98P	endrin	
99P	endrin aldehyde	
100P	heptachlor	
101P	heptachlor epoxide	
102P	α -BHC	
103P	β -BHC	
104P	γ -BHC	
105P	δ -BHC	
106P	PCB-1242	
107P	PCB-1254	
108P	PCB-1221	
109P	PCB-1232	
110P	PCB-1248	
111P	PCB-1260	
112P	PCB-1016	
113P	toxaphene	

NOT REQUIRED

* = Less than 10 ug/l
(pesticides less than 5 ug/l, an
not confirmed by GC/MS).

ND = Not detected

1/31/79

The Carborundum Company • R&D/Water Management Division • 3401 LaGrande Blvd., Sacramento, CA 95823

ANALYSIS OF WATER SAMPLES
FOR PRIORITY POLLUTANTS

Prepared for
GANNETT, FLEMING, CORDDRY & CARPENTER, INC.

By

THE CARBORUNDUM COMPANY

Prepared by

Data Certified by

Approved by

CARBORUNDUM SW-4
March 7, 1980

Phone: (916) 421-8700

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I. INTRODUCTION

ALL TABLES ARE PRESENTED IN THE APPENDIX.

The Carborundum Company is conducting an analytical program for Gannett, Fleming, Corddry and Carpenter, Inc., to determine the presence of one hundred and twenty-eight (128) Priority Pollutant compounds in water samples. Overseeing the sample taking responsibilities is Commonwealth Technology, Inc., of Lexington, Kentucky. Sampling materials, i.e., specially prepared sample bottles, shipping containers, and sample documentation forms, are being supplied by Carborundum to Commonwealth Technology, Inc., for this program.

This report contains the analytical results for two sample sets taken during the month of February, 1980. Carborundum Reports SW-1 and SW-2, dated October 18, 1979 and October 30, 1979 respectively, contained analytical results for samples taken in September of 1979, while Report SW-3, dated December 26, 1979, contained the analytical results for samples taken in October of 1979.

On February 23, 1980, two insulated shipping containers were received in the Carborundum Analytical Laboratory, Sacramento, California. The containers were immediately unpacked and the contents inspected and given internal laboratory designations. The samples were received intact and cold, with a supply of wet ice, used to preserve the samples during shipment, still remaining.

Table 4-1 presents information concerning the samples received on February 23, 1980.

II. ANALYTICAL METHODOLOGY

The analytical methodology being employed in this program has been detailed in Carborundum Report SW-1, dated October 1, 1979.

III. ANALYTICAL RESULTS

The reporting format used for organic Priority Pollutants has been detailed in Carborundum Report SW-1.

Pages 4-8 of the Appendix presents the analytical results for the extractable (acid, base/neutral and pesticide) and volatile organic Priority Pollutants.

Table 4-2 presents the analytical results for the colorimetric determinations of cyanide and phenols, while Table 3-3 presents the analytical results for metals.

IV. DISCUSSION

The Carborundum Company has completed the analytical requirements on the third set of samples submitted on this program. As informed by mail, this program has been expanded to encompass one additional set of samples scheduled to be taken in March, 1980. The necessary treated bottles, shipping container and sample documentation forms have been sent to Commonwealth Technology, Inc.

A comparison of Sample Identification information (Figure 4-1) for samples submitted on 2/23/80 with those submitted on 11/29/79 (Report SW-3) reveals that the same Sample Identification has been used for 2/23/80 and the 11/29/79 samples requiring metals, cyanide and phenols determinations. This observation is being made only to point out possible difficulties in ascertaining accurate sample identifications even though different laboratory numbers have been assigned.

APPENDIX

TABLE 4 - 1

Summary of Samples Submitted 2/23/80

for

Gannett, Fleming, Corddry, and Carpenter, Inc.

PROJECT SW

Sample Identification	Laboratory Number	Parameter (s) Evaluated	Volume of Sample Submitted
SW-A-2-S-EO	1092-1	Extractable Organics (acid, base/neutral and pesticide compounds)	1 Gallon (glass)
SW-D-2-S-EO	1092-2	Extractable Organics (acid, base/neutral and pesticide compounds)	1 Gallon (glass)
SW-A-2-S-VOA	1092-3	Volatile Organic Compounds (VOA)	2-30ml vials (glass
VOA Trip Blank	1092-4	Volatile Organic Compounds (VOA)	1-40ml vial (glass)
SW-D-2-S-VOA	1092-5	Volatile Organic Compounds (VOA)	2-30ml vials (glass
SW-A-2-S-C	1092-6	Cyanide	1 Quart (plastic)
SW-D-2-S-C	1092-7	Cyanide	1 Quart (plastic)
SW-A-2-S-M	1092-8	Metals	1 Quart (plastic)
SW-D-2-S-M	1092-9	Metals	1 Quart (plastic)
SW-A-2-S-P	1092-10	Phenols	1 Quart (amber glas
SW-D-2-S-P	1092-11	Phenols	1 Quart (amber glas

THE CARBORUNDUM ANALYTICAL LABORATORY

ACID FRACTION

SAMPLE ID SW-A-2-S-EO
LAB ID 1092-1A
DATE EXTRACTED 2/25/80
DATE INJECTED 3/5/80
STD. ID A40305
CONC. FACTOR 1700

	ACID COMPOUNDS	µg/l
21A	2,4,6- trichlorophenol	N/D
22A	p-chloro-m-cresol	N/D
24A	2- chlorophenol	N/D
31A	2,4-dichlorophenol	N/D
34A	2,4- dimethylphenol	N/D
57A	2- nitrophenol	N/D
58A	4- nitrophenol	N/D
59A	2,4- dinitrophenol	N/D
60A	4,6- dinitro-o-cresol	N/D
64A	pentachlorophenol	N/D
65A	phenol	N/D

	BASE/NEUTRAL COMPOUNDS	
1B	acenaphthene	N/D
5B	benzidine	N/D
8B	1,2, 4-trichlorobenzene	N/D
9B	hexachlorobenzene	N/D
12B	hexachloroethane	N/D
18B	bis(2-chloroethyl)ether	N/D
20B	2-chloronaphthalene	N/D
25B	1,2-dichlorobenzene	N/D
26B	1,3-dichlorobenzene	N/D
27B	1,4-dichlorobenzene	N/D
28B	3,3'-dichlorobenzidine	N/D
35B	2,4- dinitrotoluene	N/D
36B	2,6- dinitrotoluene	N/D
37B	1,2- diphenylhydrazine (as azobenzene)	N/D
39B	fluoranthene	N/D
40B	4- chlorophenyl phenyl ether	N/D

BASE/NEUTRAL ACTION

SAMPLE ID SW-A-2-S-EO
LAB ID 1092-1B
DATE EXTRACTED 2/25/80
DATE INJECTED 3/4/80
STD. ID B40304
CONC. FACTOR 1700

	BASE/NEUTRAL COMPOUNDS	µg/l
41B	4-bromophenyl phenyl ether	N/D
42B	bis (2-chloroisopropyl) ether	N/D
43B	bis (2-chloroethoxy) methane	N/D
52B	hexachlorobutadiene	N/D
53B	hexachlorocyclopentadiene	N/D
54B	isophorone	N/D
55B	naphthalene	N/D
56B	nitrobenzene	N/D
61B	N-nitrosodimethylamine	N/D
62B	N-nitrosodiphenylamine	N/D
63B	N-nitrosodi-n-propylamine	N/D
66B	bis (2-ethylhexyl) phthalate	*
67B	butyl benzyl phthalate	*
68B	di-n-butyl phthalate	*
69B	di-n-octyl phthalate	N/D
70B	diethyl phthalate	N/D
71B	dimethyl phthalate	N/D
72B	benzo(a)anthracene	N/D
73B	benzo(a)pyrene	N/D
74B	3,4-benzofluoranthene	N/D
75B	benzo(k)fluoranthene	N/D
76B	chrysene	N/D
77B	acenaphthylene	N/D
78B	anthracene	N/D
79B	benzo(ghi)perylene	N/D
80B	fluorene	N/D
81B	phenanthrene	N/D
82B	dibenzo(a,h)anthracene	N/D
83B	indeno(1,2,3-cd)pyrene	N/D
84B	pyrene	N/D
129B	2,3,7,8-tetrachlorodibenzo-p-dioxin	N/D

THE CARBORUNDUM ANALYTICAL

130 VOLATILE FRACTION

MPLE ID SW-D-S-VOA
B ID 1092-3V
TE INJECTED 3/4/80
D ID V20304
NC. FACTOR 1

PESTICIDE FRACTION

SAMPLE ID SW-D-2-S-EO
LAB ID 1092-2P
DATE EXTRACTED 2/26/80
DATE INJECTED 3/19/80
STD. ID P0319
CONC. FACTOR 32

	VOLATILES	µg/l
	acrolein	N/D
	acrylonitrile	N/D
	benzene	*
	carbon tetrachloride	N/D
	chlorobenzene	N/D
V	1,2-dichloroethane	N/D
V	1,1,1-trichloroethane	N/D
3V	1,1-dichloroethane	N/D
V	1,1,2-trichloroethane	N/D
5V	1,1,2,2-tetrachloroethane	N/D
6V	chloroethane	N/D
7V	bis (chloromethyl) ether	N/D
9V	2-chloroethylvinyl ether	N/D
3V	chloroform	*
9V	1,1-dichloroethylene	N/D
0V	1,2-trans-dichloroethylene	N/D
2V	1,2-dichloropropane	N/D
3V	1,3-dichloropropylene	N/D
8V	ethylbenzene	N/D
4V	methylene chloride	*
5V	methyl chlorid	N/D
6V	methyl bromide	N/D
7V	bromoform	N/D
8V	dichlorobromomethane	N/D
9V	trichlorofluoromethane	N/D
0V	dichlorodifluoromethane	N/D
1V	chlorodibromomethane	N/D
5V	tetrachloroethylene	*
6V	toluene	*
7V	trichloroethylene	N/D
8V	vinyl chloride	N/D

	PESTICIDES	µg/l
89P	aldrin	N/D
90P	dieldrin	N/D
91P	chlordane	N/D
92P	4,4'-DDT	N/D
93P	4,4'-DDE	N/D
94P	4,4'-DDD	N/D
95P	α-endosulfan	N/D
96P	β-endosulfan	N/D
97P	endosulfan sulfate	N/D
98P	endrin	N/D
99P	endrin aldehyde	N/D
100P	heptachlor	N/D
101P	heptachlor epoxide	N/D
102P	α-BHC	N/D
103P	β-BHC	N/D
104P	γ-BHC	N/D
105P	δ-BHC	N/D
106P	PCB-1242	N/D
107P	PCB-1254	N/D
108P	PCB-1221	N/D
109P	PCB-1232	N/D
110P	PCB-1248	N/D
111P	PCB-1260	N/D
112P	PCB-1016	N/D
113P	toxaphene	N/D

* = Less than 10 ug/l
(pesticides less than 5 ug/l, and not confirmed by GC/MS).

ND = Not detected

THE CARBORUNDUM ANALYTICAL LABORATORY

ACID FRACTION

MPLE ID SW-D-2-S-EO
B ID 1092-2A
TE EXTRACTED 2/25/80
TE INJECTED 3/5/80
D. ID A40305
NC. FACTOR 1700

	ACID COMPOUNDS	µg/l
A	2,4,6- trichlorophenol	*
2A	p-chloro-m-cresol	N/D
A	2- chlorophenol	N/D
A	2,4-dichlorophenol	N/D
A	2,4- dimethylphenol	N/D
7A	2- nitrophenol	N/D
8A	4- nitrophenol	N/D
9A	2,4- dinitrophenol	N/D
0A	4,6- dinitro-o-cresol	N/D
4A	pentachlorophenol	N/D
5A	phenol	*

	BASE/NEUTRAL COMPOUNDS	
B	acenaphthene	N/D
B	benzidine	N/D
B	1,2, 4-trichlorobenzene	N/D
B	hexachlorobenzene	N/D
2B	hexachloroethane	N/D
8B	bis(2-chloroethyl)ether	N/D
0B	2-chloronaphthalene	N/D
5B	1,2-dichlorobenzene	N/D
6B	1,3-dichlorobenzene	N/D
7B	1,4-dichlorobenzene	N/D
8B	3,3'-dichlorobenzidine	N/D
5B	2,4- dinitrotoluene	N/D
6B	2,6- dinitrotoluene	N/D
7B	1,2- diphenylhydrazine (as azobenzene)	N/D
9B	fluoranthene	N/D
0B	4- chlorophenyl phenyl ether	N/D

BASE/NEUTRAL FRACTION

SAMPLE ID SW-D-2-S-EO
LAB ID 1092-2B
DATE EXTRACTED 2/25/80
DATE INJECTED 3/4/80
STD. ID B40304
CONC. FACTOR 1700

	BASE/NEUTRAL COMPOUNDS	µg/l
41B	4-bromophenyl phenyl ether	N/D
42B	bis (2-chloroisopropyl) ether	N/D
43B	bis (2-chloroethoxy) methane	N/D
52B	hexachlorobutadiene	N/D
53B	hexachlorocyclopentadiene	N/D
54B	isophorone	N/D
55B	naphthalene	N/D
56B	nitrobenzene	N/D
61B	N-nitrosodimethylamine	N/D
62B	N-nitrosodiphenylamine	N/D
63B	N-nitrosodi-n-propylamine	N/D
66B	bis (2-ethylhexyl) phthalate	*
67B	butyl benzyl phthalate	N/D
68B	di-n-butyl phthalate	23
69B	di-n-octyl phthalate	N/D
70B	diethyl phthalate	N/D
71B	dimethyl phthalate	N/D
72B	benzo(a)anthracene	N/D
73B	benzo(a)pyrene	N/D
74B	3,4-benzofluoranthene	N/D
75B	benzo(k)fluoranthene	N/D
76B	chrysene	N/D
77B	acenaphthylene	N/D
78B	anthracene	N/D
79B	benzo(ghi)perylene	N/D
80B	fluorene	N/D
81B	phenanthrene	N/D
82B	dibenzo(a,h)anthracene	N/D
83B	indeno(1,2,3-cd)pyrene	N/D
84B	pyrene	N/D
129B	2,3,7,8-tetrachlorodibenzo-p-dioxin	N/D

THE CARBORUNDUM ANALYTICAL LABORATORY

VOLATILE FRACTION

AMPLE ID SW-A-2-S-VOA
AB ID 1092-3V
ATE INJECTED 3/4/80
TD. ID V20304
ONC. FACTOR 1

PESTICIDE FRACTION

SAMPLE ID SW-A-2-S-EO
LAB ID 1092-1P
DATE EXTRACTED 2/26/80
DATE INJECTED 3/19/80
STD. ID P0319
CONC. FACTOR 32

	VOLATILES	µg/l
V	acrolein	N/D
V	acrylonitrile	N/D
V	benzene	*
V	carbon tetrachloride	N/D
V	chlorobenzene	N/D
0V	1,2-dichloroethane	N/D
1V	1,1,1-trichloroethane	N/D
3V	1,1-dichloroethane	N/D
4V	1,1,2-trichloroethane	N/D
5V	1,1,2,2-tetrachloroethane	N/D
6V	chloroethane	N/D
7V	bis (chloromethyl) ether	N/D
9V	2-chloroethylvinyl ether	N/D
3V	chloroform	*
9V	1,1-dichloroethylene	N/D
0V	1,2-trans-dichloroethylene	N/D
2V	1,2-dichloropropane	N/D
3V	1,3-dichloropropylene	N/D
8V	ethylbenzene	N/D
4V	methylene chloride	2100
5V	methyl chlorid	N/D
6V	methyl bromide	N/D
7V	bromoform	N/D
8V	dichlorobromomethane	N/D
9V	trichlorofluoromethane	N/D
0V	dichlorodifluoromethane	N/D
1V	chlorodibromomethane	N/D
5V	tetrachloroethylene	*
6V	toluene	*
7V	trichloroethylene	N/D
8V	vinyl chloride	N/D

	PESTICIDES	µg/l
89P	aldrin	N/D
90P	dieldrin	N/D
91P	chlordane	N/D
92P	4,4'-DDT	N/D
93P	4,4'-DDE	N/D
94P	4,4'-DDD	N/D
95P	α-endosulfan	N/D
96P	β-endosulfan	N/D
97P	endosulfan sulfate	N/D
98P	endrin	N/D
99P	endrin aldehyde	N/D
100P	heptachlor	N/D
101P	heptachlor epoxide	N/D
102P	α-BHC	N/D
103P	β-BHC	N/D
104P	γ-BHC	N/D
105P	δ-BHC	N/D
106P	PCB-1242	N/D
107P	PCB-1254	N/D
108P	PCB-1221	N/D
109P	PCB-1232	N/D
110P	PCB-1248	N/D
111P	PCB-1260	N/D
112P	PCB-1016	N/D
113P	toxaphene	N/D

* = Less than 10 ug/l
(pesticides less than 5 ug/l, and
not confirmed by GC/MS).

ND = Not detected

THE CARBORUNDUM ANALYTICAL LABORATORY

VOLATILE FRACTION

SAMPLE ID VOA TRIP BLANK
LAB ID 1092-4V
DATE INJECTED 3/4/80
STD. ID V20304
CONC. FACTOR 1

PESTICIDE FRACTION

SAMPLE ID
LAB ID
DATE EXTRACTED
DATE INJECTED
STD. ID
CONC. FACTOR

	VOLATILES	µg/l
2V	acrolein	N/D
3V	acrylonitrile	N/D
4V	benzene	*
6V	carbon tetrachloride	N/D
7V	chlorobenzene	N/D
10V	1,2-dichloroethane	N/D
11V	1,1,1-trichloroethane	N/D
13V	1,1-dichloroethane	N/D
14V	1,1,2-trichloroethane	N/D
15V	1,1,2,2-tetrachloroethane	N/D
16V	chloroethane	N/D
17V	bis (chloromethyl) ether	N/D
19V	2-chloroethylvinyl ether	N/D
23V	chloroform	*
29V	1,1-dichloroethylene	N/D
30V	1,2-trans-dichloroethylene	N/D
32V	1,2-dichloropropane	N/D
33V	1,3-dichloropropylene	N/D
38V	ethylbenzene	N/D
44V	methylene chloride	*
45V	methyl chlorid	N/D
46V	methyl bromide	N/D
47V	bromoform	N/D
48V	dichlorobromomethane	N/D
49V	trichlorofluoromethane	N/D
50V	dichlorodifluoromethane	N/D
51V	chlorodibromomethane	N/D
85V	tetrachloroethylene	N/D
86V	toluene	*
87V	trichloroethylene	N/D
V	vinyl chloride	N/D

	PESTICIDES	µg/l
89P	aldrin	
90P	dieldrin	
91P	chlordane	
92P	4,4'-DDT	
93P	4,4'-DDE	
94P	4,4'-DDD	
95P	α-endosulfan	
96P	β-endosulfan	
97P	endosulfan sulfate	
98P	endrin	
99P	endrin aldehyde	
100P	heptachlor	
101P	heptachlor epoxide	
102P	α-BHC	
103P	β-BHC	
104P	γ-BHC	
105P	δ-BHC	
106P	PCB-1242	
107P	PCB-1254	
108P	PCB-1221	
109P	PCB-1232	
110P	PCB-1248	
111P	PCB-1260	
112P	PCB-1016	
113P	toxaphene	

NOT REQUIRED

* = Less than 10 ug/l (pesticides less than 5 ug/l, and not confirmed by GC/MS).

ND = Not detected

TABLF 4 - 2

ANALYTICAL RESULTS: Cyanide and Phenols

Samples(1) Analyzed for

Gannett, Fleming, Corddry and Carpenter, Inc.

PROJECT SW

SAMPLE ID	CYANIDE (ug/l)	PHENOLS (ug/l)
SW-A-2-S-C	< 2	-
SW-D-2-S-C	2	-
SW-A-2-S-P	-	< 2
SW-D-2-S-P	-	4

(1) Samples received on February 23, 1980.

TABLE 4 - 3

ANALYTICAL RESULTS: Metals

Samples (1) Analyzed for

Gannett, Fleming, Corddry, and Carpenter, Inc.

PROJECT SW

Concentration in mg/l

Sample Identification	SW-A-2-S-M	SW-D-2-S-M
Lab Number	1092-8	1092-9
Arsenic	< 0.002	< 0.002
Antimony	< 0.010	< 0.010
Beryllium	< 0.002	< 0.002
Cadmium	< 0.001	< 0.001
Chromium	< 0.002	< 0.002
Copper	0.002	0.003
Lead	< 0.002	0.002
Mercury	< 0.0002	< 0.0002
Nickel	< 0.010	< 0.010
Selenium	< 0.005	< 0.005
Silver	< 0.001	< 0.001
Thallium	< 0.005	< 0.005
Zinc	0.068	0.024

(1) Samples received on February 23, 1980

RADIAN
CORPORATION

DCN 80-225-006-05

ANALYSIS OF WATER SAMPLES FOR PRIORITY POLLUTANTS

Prepared For

GANNETT, FLEMING, CORDDRY & CARPENTER, INC.

By

RADIAN CORPORATION

RADIAN SW-5
May 15, 1980

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III	ANALYTICAL RESULTS	2
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I. INTRODUCTION

All Tables are presented in the Appendix.

The Radian Corporation has been conducting an analytical program for Gannett, Fleming, Corddry and Carpenter, Inc., to determine the presence of one hundred and twenty-eight (128) Priority Pollutant compounds in water samples. Overseeing the sample taking responsibilities is Commonwealth Technology, Inc., of Lexington, Kentucky. Sampling materials, i.e., specially prepared sample bottles, shipping containers, and sample documentation forms, have been supplied by Radian to Commonwealth Technology, Inc., for this program.

This report contains the analytical results for one sample set taken during the month of April, 1980. Carborundum Reports SW-1 and SW-2, dated October 18, 1979 and October 30, 1979 respectively, contained analytical results for samples taken in September of 1979, while Report SW-3, dated December 26, 1979, contained the analytical results for samples taken in October of 1979. Carborundum Report SW-4, dated March 7, 1980, contained the analytical results for samples taken in February, 1980.

On April 17, 1980, an insulated shipping container was received in the Radian Corporation Analytical Laboratory, Sacramento, California. The container was immediately unpacked and the contents inspected and given internal laboratory designations. The samples were received intact and cold, with a supply of wet ice, used to preserve the samples during shipment, still remaining.

Table 5-1 presents information concerning the samples received on April 17, 1980.

II. ANALYTICAL METHODOLOGY

The analytical methodology being employed in this program has been detailed in Carborundum Report SW-1, dated October 1, 1979.

III. ANALYTICAL RESULTS

The reporting format used for organic Priority Pollutants has been detailed in Carborundum Report SW-1.

Pages 7-9 of the Appendix present the analytical results for the extractable (acid, base/neutral and pesticide) and volatile organic Priority Pollutants.

Table 5 - 2 presents the analytical results for the colorimetric determinations of cyanide and phenols, while Table 5-3 presents the analytical results for metals.

IV. DISCUSSION

The Radian Corporation has completed the analytical requirements on all samples submitted on this program.

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APPENDIX

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TABLE 5 - 1

Summary of Samples Submitted on 4/17/80

For

Gannett, Fleming, Corddry, and Carpenter, Inc.

SAMPLE IDENTIFICATION	LABORATORY NUMBER	PARAMETER(S) EVALUATED	VOLUME OF SAMPLE SUBMITTED
SW-A-2-d-EO	1118-1	Extractable Organics (acid, base/neutral and pesticide compounds)	1 Gallon (Glass)
SW-A-2-d-VOA	1118-2	Volatile Organic Compounds (VOA)	2-40 ml vials (Glass)
VOA Trip Blank	1118-3	Volatile Organic Compounds (VOA)	1-40 ml vial (Glass)
SW-A-2-d-C	1118-4	Cyanide	1 Quart (plastic)
SW-A-2-d-P	1118-5	Phenols	1 Quart (Amber Glass)
SW-A-2-d-M	1118-6	Metals	1 Quart (Plastic)

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TABLE 5 - 2

ANALYTICAL RESULTS: CYANIDE AND PHENOLS

Samples (1) Analyzed For

Gannett, Fleming, Corddry and Carpenter, Inc.

PROJECT SW

SAMPLE ID	CYANIDE (ug/1)	PHENOLS (ug/1)
SW-A-2-d-C	<1	--
SW-A-2-d-P	-	<1

(1) Samples received on April 17, 1980.

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TABLE 5 - 3

ANALYTICAL RESULTS: METALS

Samples(1) Analyzed For:

Gannett, Fleming, Corddry and Carpenter, Inc.

PROJECT SW

	Concentration in mg/l
Sample Identification	SW-A-2-d-M
Lab Number	1118-6
Arsenic	<0.004
Antimony	0.002
Beryllium	<0.0001
Cadmium	0.02
Chromium	0.09
Copper	<0.01
Lead	<0.01
Mercury	<0.0005
Nickel	<0.05
Selenium	<0.005
Silver	<0.01
Thallium	<0.001
Zinc	0.67

(1) Samples received on April 17, 1980.

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·144 ACID FRACTION

MPLE ID	SW-A-2-d-EO
B ID	1118-1A
ATE EXTRACTED	4/17/80
ATE INJECTED	4/22/80
D. ID	A20422
ONC. FACTOR	1700

	ACID COMPOUNDS	µg/l
A	2,4,6- trichlorophenol	N/D
A	p-chloro-m-cresol	N/D
A	2- chlorophenol	N/D
A	2,4-dichlorophenol	N/D
A	2,4- dimethylphenol	N/D
A	2- nitrophenol	N/D
3A	4- nitrophenol	N/D
9A	2,4- dinitrophenol	N/D
0A	4,6- dinitro-o-cresol	N/D
4A	pentachlorophenol	N/D
5A	phenol	N/D

	BASE/NEUTRAL COMPOUNDS	
B	acenaphthene	N/D
B	benzidine	N/D
B	1,2, 4-trichlorobenzene	N/D
B	hexachlorobenzene	N/D
2B	hexachloroethane	N/D
8B	bis(2-chloroethyl)ether	N/D
0B	2-chloronaphthalene	N/D
5B	1,2-dichlorobenzene	N/D
6B	1,3-dichlorobenzene	N/D
7B	1,4-dichlorobenzene	N/D
8B	3,3'-dichlorobenzidine	N/D
5B	2,4- dinitrotoluene	N/D
6B	2,6- dinitrotoluene	N/D
7B	1,2- diphenylhydrazine (as azobenzene)	N/D
9B	fluoranthene	*
0B	4- chlorophenyl phenyl ether	N/D

BASE/NEUTRAL FRACTION

SAMPLE ID	SW-A-2-d-EO
LAB ID	1118-1B
DATE EXTRACTED	4/17/80
DATE INJECTED	4/28/80
STD. ID	B20428
CONC. FACTOR	1700

	BASE/NEUTRAL COMPOUNDS	µg/l
41B	4-bromophenyl phenyl ether	N/D
42B	bis (2-chloroisopropyl) ether	N/D
43B	bis (2-chloroethoxy) methane	N/D
52B	hexachlorobutadiene	N/D
53B	hexachlorocyclopentadiene	N/D
54B	isophorone	*
55B	naphthalene	*
56B	nitrobenzene	N/D
61B	N-nitrosodimethylamine	N/D
62B	N-nitrosodiphenylamine	N/D
63B	N-nitrosodi-n-propylamine	N/D
66B	bis (2-ethylhexyl) phthalate	16
67B	butyl benzyl phthalate	N/D
68B	di-n-butyl phthalate	*
69B	di-n-octyl phthalate	*
70B	diethyl phthalate	*
71B	dimethyl phthalate	N/D
72B	benzo(a)anthracene	N/D
73B	benzo(a)pyrene	N/D
74B	3,4-benzofluoranthene	N/D
75B	benzo(k)fluoranthene	N/D
76B	chrysene	N/D
77B	acenaphthylene	N/D
78B	anthracene	N/D
79B	benzo(ghi)perylene	N/D
80B	fluorene	N/D
81B	phenanthrene	N/D
82B	dibenzo(a,h)anthracene	N/D
83B	indeno(1,2,3-cd)pyrene	N/D
84B	pyrene	*
129B	2,3,7,8-tetrachlorodibenzo-p-dioxin	N/D

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VOLATILE FRACTION

SAMPLE ID SW-A-2-d-VOA
LAB ID 1118-2V
DATE INJECTED 4/22/80
STD. ID V20422
CONC. FACTOR 1

	VOLATILES	µg/l
2V	acrolein	N/D
3V	acrylonitrile	N/D
4V	benzene	N/D
6V	carbon tetrachloride	N/D
7V	chlorobenzene	N/D
10V	1,2-dichloroethane	N/D
11V	1,1,1-trichloroethane	N/D
13V	1,1-dichloroethane	N/D
14V	1,1,2-trichloroethane	N/D
15V	1,1,2,2-tetrachloroethane	N/D
16V	chloroethane	N/D
17V	bis (chloromethyl) ether	N/D
19V	2-chloroethylvinyl ether	N/D
23V	chloroform	*
29V	1,1-dichloroethylene	N/D
30V	1,2-trans-dichloroethylene	N/D
32V	1,2-dichloropropane	N/D
33V	1,3-dichloropropylene	N/D
38V	ethylbenzene	N/D
44V	methylene chloride	*
45V	methyl chlorid	N/D
46V	methyl bromide	N/D
47V	bromoform	N/D
48V	dichlorobromomethane	N/D
49V	trichlorofluoromethane	N/D
50V	dichlorodifluoromethane	N/D
51V	chlorodibromomethane	N/D
85V	tetrachloroethylene	N/D
86V	toluene	N/D
87V	trichloroethylene	N/D
88V	vinyl chloride	N/D

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PESTICIDE RACTION

SAMPLE ID SW-A-2-d-EO
LAB ID 1118-1P
DATE EXTRACTED 4/17/80
DATE INJECTED 4/29/80
STD. ID P042980
CONC. FACTOR 16

	PESTICIDES	µg/l
89P	aldrin	N/D
90P	dieldrin	N/D
91P	chlordane	N/D
92P	4,4'-DDT	N/D
93P	4,4'-DDE	N/D
94P	4,4'-DDD	N/D
95P	α -endosulfan	N/D
96P	β -endosulfan	N/D
97P	endosulfan sulfate	N/D
98P	endrin	N/D
99P	endrin aldehyde	N/D
100P	heptachlor	N/D
101P	heptachlor epoxide	N/D
102P	α -BHC	N/D
103P	β -BHC	N/D
104P	γ -BHC	N/D
105P	δ -BHC	N/D
106P	PCB-1242	N/D
107P	PCB-1254	N/D
108P	PCB-1221	N/D
109P	PCB-1232	N/D
110P	PCB-1248	N/D
111P	PCB-1260	N/D
112P	PCB-1016	N/D
113P	toxaphene	N/D

* = Less than 10 ug/l
(pesticides less than 5 ug/l, and not confirmed by GC/MS).

ND = Not detected

146 VOLATILE FRACTION

SAMPLE ID VOA TRIP BLANK

LAB ID 1118-3V

DATE INJECTED 4/22/80

STD. ID V20422

CONC. FACTOR 1

146 PESTICIDE FRACTION

RADIAN CORPORATION

SAMPLE ID

LAB ID

DATE EXTRACTED

DATE INJECTED

STD. ID

CONC. FACTOR

	VOLATILES	µg/l
2V	acrolein	N/D
3V	acrylonitrile	N/D
V	benzene	N/D
V	carbon tetrachloride	N/D
V	chlorobenzene	N/D
10V	1,2-dichloroethane	N/D
11V	1,1,1-trichloroethane	N/D
13V	1,1-dichloroethane	N/D
14V	1,1,2-trichloroethane	N/D
15V	1,1,2,2-tetrachloroethane	N/D
16V	chloroethane	N/D
17V	bis (chloromethyl) ether	N/D
19V	2-chloroethylvinyl ether	N/D
23V	chloroform	*
29V	1,1-dichloroethylene	N/D
30V	1,2-trans-dichloroethylene	N/D
32V	1,2-dichloropropane	N/D
33V	1,3-dichloropropylene	N/D
8V	ethylbenzene	N/D
4V	methylene chloride	*
5V	methyl chlorid	N/D
6V	methyl bromide	N/D
7V	bromoform	N/D
8V	dichlorobromomethane	N/D
9V	trichlorofluoromethane	*
0V	dichlorodifluoromethane	N/D
1V	chlorodibromomethane	N/D
5V	tetrachloroethylene	N/D
6V	toluene	N/D
7V	trichloroethylene	N/D
V	vinyl chloride	N/D

	PESTICIDES	µg/l
89P	aldrin	
90P	dieldrin	
91P	chlordane	
92P	4,4'-DDT	
93P	4,4'-DDE	
94P	4,4'-DDD	
95P	α-endosulfan	NOT REQUIRED
96P	β-endosulfan	
97P	endosulfan sulfate	
98P	endrin	
99P	endrin aldehyde	
100P	heptachlor	
101P	heptachlor epoxide	
102P	α-BHC	
103P	β-BHC	
104P	γ-BHC	
105P	δ-BHC	
106P	PCB-1242	
107P	PCB-1254	
108P	PCB-1221	
109P	PCB-1232	
110P	PCB-1248	
111P	PCB-1260	
112P	PCB-1016	
113P	toxaphene	

* = Less than 10 ug/l
(pesticides less than 5 ug/l, and not confirmed by GC/MS).

ND = Not detected